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Not So Long Ago Road Construction Was Largely a Matter of Hand Labor. The Illustration Shows Heavy Grading and Hand Loading on the Causeyville Road in Mississippi in 1912.

THE MANAGEMENT OF HIGHWAY GRADING

The First of a Series of Articles Dealing With Its Economic Aspects

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Chapter I—The Outfit Should Be of the Right Size.

GRADING work, whether done in the highway field or in some other branch of the Construction Industry, involves three fundamental operations: (1) digging and loading the material at the moment involved; (2) hauling it to some other location and (3) disposing of it at that location. In this statement of them these operations appear to be rather simple, as, in fact, they are. But, simple as they are, the systems which have been developed for handling them are so numerous, and the problems some of these systems present are so far removed from simplicity, that an examination of them with a restatement of their meaning in the light of present day devices for performing them should be of interest to all contractors who handle excavation as a part of their normal operations.

Nearly thirty years ago the writer walked onto the first of the numerous grading jobs which he has had an opportunity to observe and in many instances to study in some detail. It was a small job in the province of Leyte in the Philippine Islands. The superintendent, a vigorous aggressive man who was a profound believer in the doctrine that laborers must earn their bread by the sweat of their brows, was complaining bitterly because, although he was working his men so hard that they were threatening to leave en masse, it was not possible to keep costs

within the estimate for the job! The writer had been sent out to see what was the matter.

It was a simple grading job—a straight manual labor job. In those days most of the Orient knew nothing of any other methods. The dirt was dug by hand—mattocks were used for this purpose when the ground was a bit hard—shoveled into baskets, and carried to the fills where the baskets were dumped and their loads spread by hand. Take the world around a good many millions of cubic yards of earth are still moved every year in this same way. The problem—digging and loading, carrying and depositing—has not changed. It is only the method of doing these things that changes.

On this job the fills were high and the borrow pits were some distance away. The man who had prepared the estimate had been working where the fills were low and the borrow pits were close by. In estimating this particular job he had merely overlooked the fact that it took twice as long to carry a load 200 feet as it took to carry it 100 feet and that men couldn't climb a 20 foot fill all day with the same load they could carry onto a fill a couple of feet high! Men still overlook these same details and get the same results—the costs won't stay within the estimates!

No, the fundamentals have not changed, but the application of some of them has changed a great deal. That job was a human labor job. One hundred percent of the work it involved was done by human beings. The best manager was the man who could make the men work the hardest—make them do the most work per day. This was a matter of driving labor—pound 'em over the back, Bill! Pound 'em over the back! There was little room for any other doctrine. Management as the art of organizing work was little practiced. Somehow it just didn't fit into the scheme of things when production depended on the individual efforts of the crudest sort of unskilled laborers.

Enter the Machine Age

But that day is gone. Today, on a well equipped job one hundred percent of the work of digging and loading, of hauling and of disposing of the dug materials is done by powerful machines. Indeed, on such a job the dirt is as uncontaminated by human hands as the famous foods of which our radio announcers speak with so much emotional enthusiasm. Which, after all, would be of scant importance here were it not for one thing—that with the elimination of human labor and the demand for drive in the management of it, there has appeared in its place the fact of mechanization and the need for great skill in the selection as well as in the organization and in the utilization of the equipment complete mechanization involves. It is with the fundamental considerations on which effective mechanization is based, on the types of equipment that are available and on the factors which are to be considered in selecting them and in using them that this series of articles will deal.

Correct Tooling Important

In all heavy construction work, in grading no less than in other lines, job management today begins with correct tooling—that is with the selection of the right equipment and the right amount of it. In turn, correct tooling requires an appreciation of the processes which are to be tooled, and of their relation to each other. In grading work, these processes are few in number and, as previously noted, rather simple. The material must first be dug and loaded. It must then be hauled to the point where it is to be deposited. There it must be handled in whatever fashion the controlling specifications require. Job tooling is, then the tooling of these processes.

It Is a Long Jump from the Old Fashioned Slip Scraper to Its Up to Date Grand Child. The Top Illustration Shows an Earth Road Job in North Carolina in 1911. The Other View Shows Tractors and Scrapers Hauling to Make a Fill in Montana.

As these processes are interdependent, that is no one of them can be done independently, the tooling of each depends on the tooling of the others. In short, a balanced tooling is required.

Power shovel and elevating grader outfits illustrate the necessity for a balanced tooling. The power shovel and the elevating grader are digging and loading tools pure and simple. Wherever they are used some sort of hauling equipment must be provided to move the diggings. It necessarily follows that the efficiency with which they can operate on a given job will be dependent on the provision that has been made for hauling the diggings, and for disposing of them on the dump.

The large tractor-drawn scrapers dig and pick up their own load and then carry it to the point at which it is to be deposited. There these scrapers can deposit it in a mass or spread it in a layer of any desired thickness. Where fills must be compacted in layers, the weight of these units produces such wheel loads that they even do most of the rolling that is required. They are, then practically complete in themselves and as they are practically complete units, the problems that must be solved in working out a balanced tooling on jobs where the digging and loading is done by a unit of one type, the hauling by units of another type and the work on the dump by units of a still different type are not encountered when they are used.

The dump requires little comment here. The horse drawn blade grader has been largely replaced by motor driven graders and bulldozers. Rollers of various types are used in compacting the diggings. Sheeps foot rollers are increasing in prominence. As the compaction of highway fills receives more attention it seems likely that

their use will continue to increase. Be this as it may, there has never been much difficulty with the problem of so tooling the dump that operations here do not obstruct production. However, as the compaction of fills is given greater attention, the necessity for so equipping the dump that operations on it will not delay other operations is likely to require a good deal more attention than contractors have been accustomed to give to it. It is, of course, axiomatic that the digging and loading tool cannot take out more material than the hauling units are able to move. In turn, the hauling units cannot haul more material than the digging and loading unit can dig nor can they dispose of more material than the equipment on the dump can handle. For successful operation it may, therefore, be necessary in the near future to view the proper equipment of the dump as a very important matter for when grading is viewed as a series of three operations, each of which requires its own separate tooling and all of which must be tooled to meet some predetermined rate of production, if anything approaching efficiency in operation is to be attained, it will be apparent that if the work required to be done on the dump is increased, its proper tooling will be vital in maintaining production.

Management of Machines

Finally as to the more important general principles which are involved in the successful handling of grading work under present day conditions it seems desirable to remark that management is increasingly the management of machines—less and less the management of men. Profits lie in working out a tooling of successive processes that is consistent with the character of the work in hand, after which the problem is largely one of keeping the well designed outfit functioning normally. There is little left of the old idea of driving men. They do too little of the actual work construction involves. The actual work moving dirt involves is now done by the machines and these it is unwise and in the long run unprofitable to operate beyond the rates and the loads at which they are designed to operate. The better, and in the long run the more profitable practice is to base operation on rates of output which are consistent with the designed capacities of the various units employed. These rates it is relatively a simple matter to maintain and where managerial effort is directed toward maintaining them, smooth operation is to be expected.

Importance of Analyzing Contractor's Field

Some of the more important general principles on which proper tooling is based having been briefly outlined, it is possible to turn to a more detailed consideration

Road Scraper in Colorado in 1909.

Working the Streets in West Lafayette, Ind., with Tractor Pulling Small Blade Grader.

of the effect of these and of principles of less importance on the selection of an outfit, on its equipment and on its management on the job. Approached from this standpoint the contractor's first attention, in an examination of his tooling problem, should be given to an analysis of the field he occupies. Is grading his major activity as a contractor or is it a side line? If the former, does he operate one outfit or does he operate several? If the latter, are his activities in the grading field confined to the incidental grading almost all types of highway work involves or do his operations include dirt moving on a considerable scale? These really are very important questions because while the large operator can profitably own outfits of more than one type, the small operator—the man who runs only one or two outfits—has no such freedom of choice. His selection must be made with great care for the purchase of an outfit of the wrong size or the wrong type will be a handicap to him for some time.

The matter of size is mentioned before the matter of type because the size of the outfit in large measure determines the amount of the investment that will be involved. There is a natural tendency among contractors, as among other business men to desire to expand. This is by no means an objectionable tendency but it is a tendency which finds rational expression in some directions and expression in other directions that is not as rational.

Expansion always involves additional investment—a greater fixed capital—and quite as certainly additional charges for depreciation, repairs and operating costs, the charges necessarily incident to owning and operating equipment. These must be covered if at all, out of payments received for work performed. It naturally follows as an axiomatic truth that to justify owning an outfit at all there must be a reasonable prospect of work to do and to warrant expansion there must be excellent reasons for believing either that the amount of work there will be to do will increase or that some competitive advantage will make more of it available.

Volume of Work and Size of Outfit

This consideration of the work there is to do—the volume in which work has been available and in which it is likely to be available in the future—is an effort calmly to arrive at a reasonable appraisal of the best size of outfit to own—best here meaning the size that is likely during its useful life most definitely to harmonize with the demands for production that a careful appraisal of the situation indicates is likely to be made of it. The importance of this matter may be emphasized by calling

An Early Type of Road Scraper (1898) Used in New York.

attention to the fact that $50,000 is not an unusual investment in a grading outfit. The equipment units in such an outfit wear out at different rates but, omitting for the moment, all other ownership expense it is safe to say that depreciation alone will be not less than $10,000 a year. That is about 5 ct. a cubic yard on a season's output of 200,000 cu. yd., 6.7 ct. a cubic yard if only 150,000 cu. yd. are handled, and 10 ct. a cubic yard if production does not exceed 100,000 cu. yd. These figures are illustrative only. Still they do serve to call attention to the fact that beside the influence the choice of an outfit has on the investment that is involved, the unit cost generated by its ownership varies with the yardage produced. In the very nature of the case, it follows without much regard to what the volume of work a contractor may expect to handle may be, that his lowest unit ownership cost will be obtained when his outfit is working at capacity—in short when the size of his outfit, and his investment in it, harmonize with the volume of work he ordinarily handles.

It is sometimes argued that excess production capacity is desirable because having it, it becomes possible to take larger jobs than are usually handled when they are obtainable. The theory usually advanced as a defense of this course is that, even if the work never becomes available, nothing is lost because such an outfit will last that much longer if it is worked at less than full productive capacity. There are several very definite objections to this theory. The first of these is that following such a course results in tying up capital. If $60,000 is invested in grading equipment thereafter used to handle a volume of work that could be done just as well with an outfit costing $40,000, $20,000 of that investment isn't earning a dime.

Another reason for avoiding over large outfits lies in the fact that in the long run it is likely that the $20,000 will be lost entirely. In the past obsolescence has wiped out values about as rapidly as wear and tear has wiped them out. It seems likely that obsolescence will have about this same effect in the future. Where obsolescence does have about the same effect on values wear and tear has, the loss in the value of equipment is about the same whether it is used or not. This is, of course, only another way of saying that the man who buys a $60,000 outfit when his volume of work would warrant no more than two-thirds of that investment, will usually find that, from a percentage standpoint, the loss in value on his larger than necessary outfit has been just about the same that the smaller outfit would have shown. When the larger than necessary outfit is worn out he is, then, out of pocket the amount of his excess investment for even if he has kept the investment account intact, the extra money it has been necessary to use for this purpose has been taken out of what would otherwise have been profit.

Equipment Expense as Factor in Cost

It is perhaps as well to remark here as at any point in this series of articles that the mechanization of grading work has made several very radical changes in the emphasis that is to be given to the various aspects of management. One of the more important of these changes is found in the emphasis that must be placed on equipment expense as a factor in cost. Taking for purposes of illustration, the outfits just mentioned, that is an outfit worth new the sum of $60,000 and one worth $40,000 and assuming that annual depreciation will amount to one-fifth of the original cost, that is to $12,000 a year on the first and $8,000 per year on the second outfit, it follows as a matter of very simple computation that if an average season's production is 200,000 cu. yd., depreciation alone is costing 6 ct. a cubic yard if the larger outfit is owned but only 4 ct. per cubic yard if the smaller outfit is owned. If the season's production is 150,000 cu. yd. the cost of depreciation is 8 ct. a cubic yard for the larger outfit but is only 5.3 ct. for the smaller outfit. If it is 100,000 cu. yd. depreciation amounts to 12 ct. for the larger outfit and 8 ct. for the smaller one. In the grading field a clear margin of profit of 5 ct. a cubic yard is a pretty good margin and a great deal of yardage is handled every year on prices which do not yield a clear profit of half this amount. These figures, then, emphasize the fact that the extra cost that is involved in owning an over large outfit, to say nothing of the extra cost of operating it—that is an outfit materially larger than is required to handle the volume of work usually available—may easily exceed the margin of profit prevailing prices can be made to provide.

The Financial Position in Prequalification

There is still another aspect of this matter of buying an outfit of the right size that deserves serious consideration. The practice of requiring bidders to prequalify is growing. Moreover, the rules which govern prequalification are being pretty generally made more exacting with the result that more and more attention must constantly be given to financial position.

Under most systems of prequalification the volume of work for which a contractor may be prequalified depends

Engine and Cars Used for Hauling Crushed Stone from Quarry to Road in Oregon.

on the amount of his net current assets. For this reason his net current assets position is a matter of vital importance. The amount a contractor has invested in plant and equipment is not as a rule considered in determining the amount of work he will be permitted to handle. As, inevitably his total capital is limited, the relation between fixed assets and net working capital must then be kept on a reasonable basis. It is, of course, evident that if the total amount of capital remains unchanged any increase in the amount invested in fixed assets involves a corresponding subtraction from net current assets, that is from working as distinct from fixed capital. This being the case, the purchase of an over large outfit is pretty certain to represent the investment of too large a fraction of the total capital in equipment and the retention of too small a fraction in current assets. When this occurs, the result under prequalification is that the amount in which authorization to take work can be secured falls below the amount of work the contractor is now equipped to handle because net current assets have been too far reduced. This is a most distressing situation for any contractor who gets into it for it pretty effectively prevents him from making use of his over-investment in equipment!

To put the matter just a little differently, when a contractor over-invests in equipment, he is very apt, in so doing to have dangerously reduced his net current assets. When this occurs, the growth of prequalification renders it increasingly likely that he will find that the volume of work he is permitted to take has been reduced rather than increased, with the result, as outlined earlier in this article, that ownership expenses he cannot avoid are definitely adding to his problems.

Where net current assets permit prequalification for amounts of work in excess of the capacity of the owned equipment the situation is far simpler for needed additional equipment can then be either rented or purchased. The ideal situation is one in which net current assets afford a satisfactory basis for prequalification in an amount that is from about the same as to a little above the amount a contractor is equipped to handle.

It may seem to some that too much emphasis has been laid on the danger all contractors, but more particularly all small contractors, face in purchasing over large outfits—that is outfits larger than are needed in handling the usual volume of work. That this is not the case was strongly impressed on the writer as he recently looked through a considerable number of records involving prequalification and noted the comparatively small fraction of those who had been successful in keeping their net current assets and their investments in equipment on anything like a reasonably comparable basis. The matter was not investigated in great detail but it was evident that an impressively large fraction of the group of contractors these records covered had been unable to show net current assets on which they could carry more than a fraction of the volume of work they were equipped to handle! Purchasing over large outfits undoubtedly was at the bottom of the difficulty many of these men had had in maintaining an adequate working capital. It would seem to be probable that for many of those in this position the capital now tied up in surplus equipment ultimately will prove to be practically a total loss.

Prequalification is definitely intended to take some of the speculation out of contracting. That this is desirable can hardly be questioned. But in doing this it has introduced this relatively new factor—this added and entirely proper emphasis on financial position. For this reason it seems wise to repeat for those who have not been accustomed to give this matter much thought, that while it always is dangerous and seldom profitable to overinvest in equipment, the penalties that result from following this practice in regions where prequalification is required seem likely to be very severe in those cases in which working capital is so reduced that the amount of work that can be taken falls below the capacity of the equipment owned.

Unless otherwise indicated, all pictures are by courtesy of the Bureau of Public Roads.

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Former State Highway Engineer Heads Portland Cement Association

Election of Frank T. Sheets as president of the Portland Cement Association, effective Sept. 1, was announced July 1 by Charles L. Hogan of New York, chairman of the Board. He succeeds Edward J. Mehren, who resigned last month to take care of his personal interests.

Mr. Sheets for the past four years has been consulting engineer and director of development of the Association.

Prior to that time he had been associated with the Illinois Highway Department for twenty-three years and for 12 years as superintendent of highways and chief engineer.

Coming out of high school Mr. Sheets started to work in the Department of Highways as blueprint boy and file clerk. He then took time off to go to college, working his way through, being employed by the State Highway Department during the summer in order to get additional revenue for his education. At the completion of his college course he entered the Highway Department and in successive civil service examinations became assistant engineer, assistant bridge engineer, assistant maintenance engineer, bridge engineer, engineer of design and finally the top position of superintendent of highways and chief engineer. His selection for this position was based solely on his outstanding ability and the success with which he handled his successive jobs.

Mr. Sheets has served as president of the American Association of State Highway Officials, of the Mississippi Valley Highway Conference, of the Central Illinois section of the American Society of Civil Engineers. He was an official delegate from the United States government to the Pan-American Highway Congress at Rio de Janiero in 1929.

His experience in the highway field covers practically all phases of highway financing, design, construction, maintenance and administration. During the twelve years ending January 1, 1933, he directed expenditure of over $450,000,000 for highway and bridge construction and maintenance and supervised construction of approximately 11,600 miles of highways in the state of Illinois of which 8,356 miles were high type primary roads.

He is the author of "Concrete Road Design, Simplified and Correlated with Traffic" presenting sound and simplified methods of designing pavements to meet traffic expectancy. He has, during the past few years directed the administrative and technical policies of the Highways Bureau of the Association, and has directed industrial research to develop new and improved uses of portland cement and concrete, in addition to performing his duties as consulting engineer.

CLIMATIC CYCLES SHOWN IN GEOLOGICAL DATA

A Paper Presented to the American Meteorological Society June 21, 1937

By HALBERT P. GILLETTE

Synopsis

GEOLOGICAL data abound in evidence of climatic cycles of different lengths. Series of pairs of beds of shale and limestone, regularly spaced terraces along rivers and around lake and sea shores, regularly spaced recessional moraines, series of calcareous floors in limestone caves, series of fossilferous zones—all proclaim the effects of climatic cycles.

The earth is encased in several ionospheres that are probably rotating electron-shells whose axes are gyrating. Let there be 8 of those shells whose axes gyrate in harmony with the earth's orbital period and many magnetic cycles must result, ranging in length from a few days to many millions of years. At the crest of each cycle the increased magnetism induced in the earth shortens its polar axis, increasing the earth's oblateness. This raises the land in low latitudes and depresses it in high latitudes. There is a sea level cycle of about 615 years and a weather cycle of that length shown in recessional moraines and in varves.

Increased oblateness of the earth reduces its rate of axial rotation, lengthening the day. There are two known cycles in the day's length, of about 39 and 235 days, and they are correlated with two weather cycles of the same length.

Belts of molten cyclones have evidently existed in the earth's core, similar to those that have solidified on the moon to form its "craters" and "seas." These are magnetic rotation phenomena, resembling atmospheric cyclones which are similarly caused. The latter produce vertical circulation of the air, cooling it near the earth's surface, and in extreme cases causing ice-ages. The correlations of arcs of great crustal uplift and of ice-ages is thus explained.

Sedimentary rocks indicate 9 Geological Revolution Cycles, each of which embraced 3 Geological Periods, or a total of 27 grand cycles since the beginning of sedimentation. The Ice Age cycle, which is about 24,000 years long, is very conspicuous only near peaks of Geological Revolutions. Three Ice Ages have occurred during the present Quarternary Age, the peak of the last one being about 15,300 year ago.—End of Synopsis.

Geological formations abound in evidence of climatic cycles of different lengths. Alternate beds of shale and limestone, for example, show the wet and dry periods of a climatic cycle. Frequently 15 or more pairs of such beds occur in sequence and are so uniform in thickness as to leave no doubt that the cycle was very regular in length. Seams of coal of about the same thickness are often spaced so uniformly in the geological column as to tell the same sort of a cyclic tale. Recessional moraines left by the last great ice-sheet occur in a long series of a dozen or more, so regularly spaced as to indicate cyclic retardations in the retreat of the glacial ice. The same is true of the smaller ridges that at times occur on wide recessional moraines. Raised beaches around existing lakes frequently form a series of 8 or more, so regularly spaced as to leave no doubt that a climatic cycle of considerable length and of great amplitude caused them. The same is true of terraces along river valleys, of which as many as 12 are to be seen on the Columbia River.

Raised beaches along the sea shore are so strikingly like those around lakes as to suggest the same cause. Yet how could a rainfall cycle affect sea levels? Probably it does not, yet the cause of a rain cycle may also be the cause of changes in the oblateness of the globe, and thus in sea levels.

Limestone caves at times show several layers of earth separated by floors of precipitated calcium carbonate, indicating cyclic deposition. Since limestone is slightly soluble in water containing carbonic acid gas, it follows that when rainfall is frequent more limestone is dissolved by the water that filters through it, and consequently more is precipitated on the floor of a cave as the water evaporates. As many as 11 such layers have been found in one cave.

The cycles thus indicated, (1) by paired beds of argillaceous and calcareous stone, (2) by series of coal and oil-shale beds, (3) by recessional moraines and drumlins, (4) by lake, river and marine terraces, and (5) by limestone floors in caves, are usually relatively short climatic cycles when measured on the grand scale of geological time; yet the major coal bed cycle, for example, is probably of the order of 24,000 years, while the major lake and river terrace cycles are probably of the order of 600 years. Long as such cycles seem, they are short indeed compared with the cycle between successive geological revolutions, which may be termed the Revolution Cycle.

Geologists have given names to the last seven geological revolutions, the oldest being the Algomian Revolution, the youngest being the Cascadian Revolution. Each of these seven was characterized not only by great crustal uplifts but by long continued glaciation. The Cascadian Revolution was accompanied by the Nebraskan Ice Age, and followed by the Kansan Ice Age and the Wisconsin Ice Age at comparatively short intervals—about 24,000 years apart.

We come now to a very significant fact, namely that the maximum thickness of sedimentary rock between successive geological revolutions does not differ greatly. It ranges only from 43,000 to 61,000 ft., the average being about 52,000 ft. An extreme departure of only 18 per cent from this average clearly shows that the Revolution Cycle was either constant in length or not greatly variable.

In using the maximum rock thickness as a means of measuring relative time, I am following Prof. Sollas and several other geologists who have investigated this subject thoroughly.

I find that each Revolution Cycle is divisible into three cycles whose average thickness of rock is about 17,000 ft. Let us call this shorter cycle a Geological Period, of which there have been 18 since the Algomian Revolution. Names have been given to 14 of these 18 Periods; and three of these Periods are embraced under one name, the Cretaceous System. Since the maximum thickness of that system is 44,000 ft., and since it has been divided by geologists into Lower, Middle and Upper Cretaceous, it is evident that each of these three divisions is a separate Period. Moreover, the Cretaceous System lies between the Sierra Nevada Revolution and the Laramide Revolution, and it is the only one of the systems thus filling an entire Revolution Cycle. Between the Laramide and the Cascadian Revolutions geologists in recent years have listed 4 Periods where formerly there were but 3. I think the earlier geologists were right, and that the correct number is 3. If so and if the Cretaceous System is divided into 3 Periods, then there are 3 subcycles in every Revolution Cycle. Each of these subcycles is a Geological Period during which an average of 17,000 ft. of rock was deposited where erosion was a maximum. While the range is 12,000 to 29,000 ft. of rock in these 18 Periods, there are 13 of them whose range was only 12,000 to 18,000 ft. Hence these 13 have a range of only 20 per cent greater or less than 15,000 ft. This is strong evidence of a climatic cycle of tolerably constant length that may be called a Geological Period.

Of the last 7 Revolutions, 3 are outstanding both as to glaciation and crustal uplift, namely the Algomian, the Appalachian and the Cascadian; the first at the beginning, and the next in the middle and the last at the end of this vast stretch of time. In short, here is another cycle 3 times as long as a Revolution Cycle and 9 times as long as a Geological Period! Let us call this supercycle a Geological Age. Since the Algomian Revolution there have been two of these Ages, during which 170,000 and 146,000 ft. of sedimentary rock were deposited where erosion was a maximum. But prior to these two ages a third evidently occurred, for below the Algomian Revolution lies 173,000 ft. of sedimentary rock. Calling this lowest mass the Primary Age, we have above it the Secondary and Tertiary Ages; and we are living in the Quartenary Age that was recently ushered in by the Cascadian Revolution. Although geologists have used the terms Primary, Secondary, Tertiary and Quartenary, they have not applied them to the geological column in the manner above outlined. My basis of subdivision has been the Revolution Cycle, which itself is, I think, a subcycle of one of the grandest of all climatic cycles, the Geological Age.

In subdividing and naming the strata, geologists have been mainly guided by the evidence of fossils. Since climatic cycles have had a profound effect upon the evolution of species, paleontological evidence has properly been the main basis for the subdivision of the geological column. Latterly, however, since evidence of great crustal uplifts, or revolutions, has accumulated, these have been used as supplementary guides. I have simply carried this use to its logical conclusion.

Since sediments were first formed there probably have been 10 Revolutions or 9 Revolution Cycles, or 27 Geological Periods prior to the one in which we now live.

One of the great geological puzzles has been the cause of Ice Ages at times of great disturbances of the earth's crust. It seems to me that this correlation can be explained by the electron theory in a way that fits all the important facts. Moreover, this theory has the merit of explaining not only the greatest of general crustal uplifts and depressions but the smallest. Finally it shows why the length of the day is not constant, but varies in a periodic manner.

It is known that several ionospheres encase the earth. Since the earth constantly emits electrons it is probable that these are electronospheres or electron shells. If so their axes must gyrate, thus causing magnetic cycles. If they gyrate in harmony with the earth's orbital period they gyrate in harmony with one another and cause compound cycles whose lengths are the least common multiples of any two or more shorter cycles. In this way 8 electronospheres gyrating in periods ranging from a few days to a few years probably cause all the important weather and climatic cycles, even the Geological Age that is millions of years long, the latter occurring when the axes of all the electron-shells coincide.

To account for the rainfall that accompanies the peaks of magnetic cycles, we need only assume that the circulation of the air is considerably affected by the magnetic field, as Faraday suggested. Since the air is ionized it must be influenced by that field wherever it contains a preponderance of either positive or negative ions. According to Faraday's principle of magnetic rotation of electric currents, the atmosphere should frequently show spiral whirls. It does show them in cyclonic and anticyclonic forms, both on small and on large scales. The vertical circulation thus caused lowers the temperatures near the earth's surface; and if sufficiently vigorous may cause an Ice Age. Coincidently the electrons escape along the earth's axis in greater numbers, and at the same time certain orbital electrons of atoms tend to orient themselves relative to that axis. The resulting increase in the earth's magnetism compresses it along its axis, thus increasing the earth's oblateness. This causes the earth to rotate more slowly, lengthening the day. It also causes the sea to flow from low to high latitudes. Moreover the greatest changes in sea level occur at the poles and at the equator, while the latitude of no change is slightly below 45° N and 45° S.

In addition to these general movements of the land there are regional and local movements probably resulting from cyclonic whirls in the earth's core analogous to those in its atmosphere. Along circular arcs the Revolution uplifts occurred, in a manner analogous to the moon's "craters" and "seas."

It was long ago found that in northern Sweden, about 30° from the north pole, the land has risen about 1000 ft. since the peak of the last Ice Ages, and to much less height in southern Sweden. Near the mouth of the Mississippi, about 30° N of the equator, the land has sunk about 1000 ft., as is shown by the old bottom of the river out in the Gulf of Mexico, whereas the land has sunk only about 250 ft. near the mouth of the Hudson River as shown by its old valley now beneath the ocean. The above given theory of periodic changes in sea level indicates that we are now not far from a valley of the Ice Age cycle, for nothern Sweden has been uplifted about as much as the mouth of the Mississippi has been depressed, both localities being about equally distant from latitude 45° N.

This inference is confirmed by the existence of marine terraces on Anticosti Island about 50° N and terraces on the Atlantic coast of Florida about 30° N. The Anticosti terraces number 22, but a gap in their spacing indicates that 3 more are missing, making 25 raised sea beaches that have been cut in the rock by wave action. There are six raised beaches on the Florida coast, spaced about 50 feet apart vertically, the lowest being about 25 ft. above mean sea level. This shows that about 5.5

cycles have elapsed since the warm valley of the Ice Age cycle, whereas the Anticosti Island terraces show that about 25 cycles have elapsed since the cold peak of the Ice Age cycle. What is the length of the cycle that has caused these raised beaches? About 36 years ago Pearson published his discovery of a cycle of the order of 600 years in the change of sea levels. I find excellent evidence of a cycle of 615 years, caused by cycles of 15 and 123 years. Every third peak is the highest, causing a cycle of 1845 years, the last peak being in 1410 A.D.

By means of annual silt layers, or varves, in ancient glacial lakes, Antevs has determined the rate of retreat of the ice sheet for 150 miles in New England. Using that rate of retreat, the spacing of moraines can be used to determine the approximate length of long cycles. There is unquestionably an important climatic cycle of the order of 615 years, and tree-rings and varves indicate that its subcycles are a whole number of years long so that it is exactly 615 years.

By aid of this cycle applied to the 25 Anticosti Island terraces I find that the peak of the last Ice Age was about 15,400 years ago. Since land in Florida has been rising for 5.5 of these cycles of 615 years, the warm valley of the Ice Age Cycle was about 3400 years ago. Hence the Ice Age Cycles peak and valley were about 12,000 years apart, indicating that the length of that cycle is of the order of 24,000 years.

As a check upon this we have the estimated age of the Muota Delta in Lake Geneva which has been forming since about the peak of the Ice Age. Based on recent rates of accumulation of silt there, the age of the delta is 16,000 years according to Heim. Perfiliev measured 1620 annual silt layers or varves in 2 meters of the ooze of Lake Saki, Russia, where the total silt depth is 20 meters. This indicates an accumulation of ooze for about 16,000 years, or back to about the peak of the last Ice Age.

There are other facts that point toward a climatic cycle of the order of 24,000 years.

Brown has found a cycle of about 40 years in the Moon's aberrations, presumably resulting from a cyclic change in the earth's oblateness that changes the length of the day. I have found a 39 year rainfall cycle that fits quite well the epochs of Brown's cycle. His lunar data also indicate a similar cycle of about 235 years, and I have found a rain cycle of that length. It is well seen in sequoia ring thickness.

Fortunately the theory that the globe contracts considerably under magnetic pressure can be tested by facts of another sort. Since the north magnetic pole is more than 2000 miles from the axial pole, it follows that if the earth has contracted along its magnetic axis the equator can not be a circle, but must be slightly elliptical. Moreover the short axis of that ellipse must be close to the meridian that passes through the north magnetic pole. I find that both of these deductions from the theory are correct, and that the difference between the lengths of the axes of the elliptical equator is nearly two miles! The ellipticity of the equator has hitherto lacked explanation, although it has been known for more than 75 years. I regard this equatorial ellipticity as being convincing evidence of great magnetic compressive force in the earth, for it indicates a shortening of nearly 3 miles along the magnetic axis as a result of the present magnetization.

It is noteworthy that short weather cycles are much less obtrusive than long climatic cycles. The theory above outlined explains this difference; for the longer the cycle the greater the number of subcycles that have combined to cause it, and therefore the greater its amplitude, or up and down swing from normal. This is the reason why geological cycles of great length stand forth so conspicuously as to have led nearly all geologists to be firm believers in climatic cycles.

Meteorologists will be wise, I think to turn their attention to geological data, and especially to engage in measuring varves both in existing and in ancient lakes as well as in rocks. Up to the present only two meteorologists, both Russians, have published varve measurements, namely Perfiliev and Schostakowitch.

Cycle problems will never be solved merely by study of man-kept records, for they cover too short a period. Nature-kept records fortunately supply all the data needed for a solution of the most important of these problems.

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Book Reviews

ELEMENTARY SURVEYING, by William Horace Rayner, C.E., M.S., Assistant Professor of Civil Engineering, University of Illinois, 380 pages, 5½ in. by 8 in., flexible binding. D. Van Nostrand Co., Inc., 250 Fourth Ave., New York, Publishers. Price $3.00.

This book is an elementary discussion of the practice of surveying.

It is divided into three general groupings: Section I includes Chapters 1 to 5 which describe the use and adjustment of the instruments properly used to measure direction, distance, and elevation.

Section II includes Chapters 6 to 15 which describe the procedure of conducting field surveys, together with the methods of computing and mapping necessary to such work.

Section III is Chapter 16 which supplies that minimum of information about land surveying which every engineer should know.

▼

MUNICIPAL AND RURAL SANITATION, by Victor M. Ehlers, C.E., Chief Sanitary Engineer, State Health Department of Texas, and Ernest W. Steele, C.E., Professor of Municipal and Sanitary Engineering, Agricultural and Mechanical College of Texas. Second edition, 477 pages, 6 in. by 9 in., hard cloth binding. McGraw-Hill Book Co., 330 West 42nd St., New York, N.Y., Publishers. Price, $4.00.

Sanitation is a thing that suffered during the depression both in cities and the country. State highway department maintenance forces did consistent work between right of way lines but the practice of sanitation suffered to varying degrees, elsewhere. One of the execllent features of this book is the numerous illustrations and sketches. This reviewer would have liked to have seen the subject of Weed Control discussed in this book because of the contribution toward insect protection afforded by various weeds.

Because of the rapid increase in trailer travel and concentrations of trailers in large camp groups, a sanitation problem is presented that needs immediate attention and solution. This problem could well have been included. However, the fundamentals are discussed and details of particular locations might be developed from information presented in this book.

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$23,000,000 TO BE SPENT BY OHIO—A total of 199 projects are included in the Ohio State Highway Department's $23,000,000 highway construction program. The program includes 86 regular federal aid programs totaling $18,500,000; 48 federal aid secondary road projects, $2,000,000, and 65 state widening and resurfacing projects, $2,500,000 to be completed this year. Contracts on all federal aid projects will be let by June 30, 1938.

COLORADO PROSECUTES LOW COST BITUMINOUS ROAD PROGRAM

Heavy Bridging, Grade and Alignment Construction Results from Sale of Anticipation Warrants

By VICTOR J. BROWN
Publishing Director, Roads and Streets

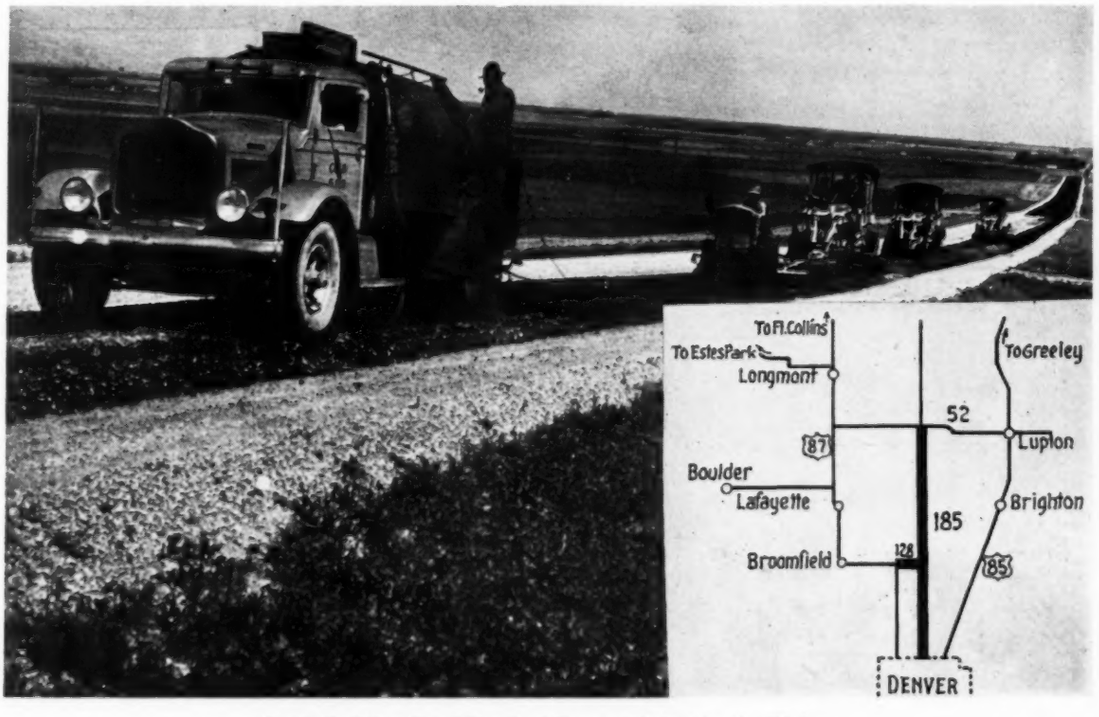
SIGNIFICANT as a policy for highway improvement is the bituminous road building in Colorado. Construction of low cost bituminous highways by the roadmix method in this state is handled by the maintenance department and the work is known in the state as building an oiled road. Some years ago the people began to demand dustless, mudless, fast highways. Mr. C. D. Vail, State Highway Engineer, decided upon bituminous surfacing as the most economic method considering demand and the funds available.

Recognizing the demand for better highways, the administration decided to sell $25,000,000 worth of anticipation warrants. The amount was arbitrarily selected since very much more is required to complete the grading, drainage and gravelling for which the funds will be used.

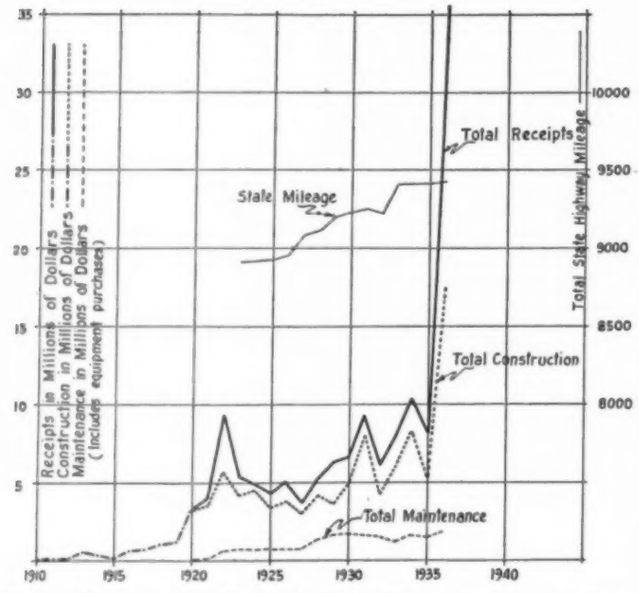
Financial

Revenues gradually increased over the years with the increase in automobile registrations. An accompanying set of curves shows the total receipts, also construction and maintenance expenditures. A few smaller items have not been shown. The mileage curve was plotted with the revenue and disbursement curves to show how little the state system has increased. Since there was such a large growth in motor vehicle registration, as shown by another curve herewith, the highway department was pressed for better driving surfaces and better grades and widths. So the anticipation warrant sale was proposed.

The first block of $10,000,000 was sold in June, 1936. Those funds are all contracted or expended. In December, 1936, the second block of $15,000,000 was sold



Outfit Building Road North of Denver Visited by the Writer.



Curve Showing Receipts, and Expenditures for Construction and Maintenance.

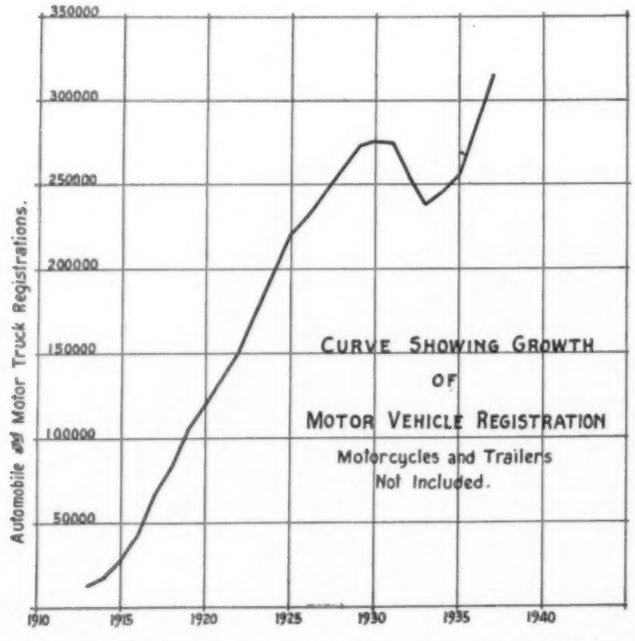
and will provide funds for the balance of this year and next year. The next allotment of regular federal aid will have been made available by the time this is printed and to this will be added about $5,000,000 from gas tax and motor vehicle license fees. The amount available for construction during the next year will be around $17,000,000. Colorado attempted to get a PWA grant large enough to match their $25,000,000 of anticipation warrants but were successful in obtaining only $3,000,000. The latter will have been contracted by the time this article is printed.

Maintenance

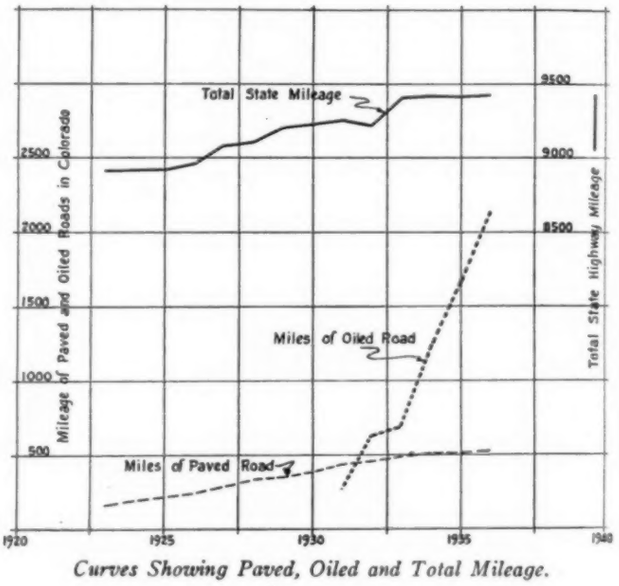
When a road is built from a construction budget it is surfaced with stabilized gravel about 6 in. thick. Accurate sieve analyses, plasticity and liquid limit tests control the stabilized gravel as it is being placed. Road oiling is done only on those roads which have been graded and gravelled at some previous time. In some cases, with the older construction, where the gravel has been solidly packed into the grade, about 1000 tons per mile of new material are added. Only the newer lightly compacted road surfaces are scarified.

To further the oil-surfacing program it was decided to place a complete road mix outfit in each of the seven districts. An accompanying curve shows how the dustless all-weather bituminous mat-coat surfaced mileage has increased. This rate of progress is anticipated to continue until the present gravel surfaced roads are all oiled. The curve also shows paved mileage as well as total mileage. It will be noted from the chart that the paved mileage curve is about parallel to the total mileage curve, which indicates that the rate of increase in paved mileage was entirely too small and no progress was being made toward completing the hard surfacing of the system.

Consequently something had to be done and oil treating the gravel already in the road surface was considered the economic plan. The annual budget for 1937 set up an item of state oiling projects in the amount of $1,200,000. This was in addition to the $1,600,000 set up for maintenance, repairs and equipment.



Motor Vehicle Registration Curve, Passenger Cars and Motor Trucks Only.



Curves Showing Paved, Oiled and Total Mileage.

Colorado has established rigid inspection requirements and selective specifications for bitumen. The

CONDITION MILEAGE TABLE COLORADO STATE HIGHWAY SYSTEM

	Graded	*Surfaced*	*Paved*		*Total Mileage State Highways*	*Federal Aid Mileage*
1923	5,332.8	3,181.5	167.3		8,923	
1924	5,296.2	3,208.5	199.9		8,928	3,274.9
1925	5,258.6	3,231.7	225.1		8,932.8	3,258.2
1926	5,186.6	3,247.5	251.8		8,966.6	3,353.7
1927	5,114.6	3,476.2	293.3		9,095.4	3,243.4
1928	4,732.5	3,797.0	343.2		9,119.9	3,238.2
1929	4,735.0	3,839.5	352.6		9,202.6	3,225.2
1930	4,601.2	3,981.2	394.2		9,234.6	3,408.5
			Oiled	*Paved*		
1931	4,359.2	3,948.3	254.1	447.1	9,254.9	3,493.7
1932	4,241.6	3,681.0	622.4	467.0	9,236.0	3,570.6
1933	4,107.6	3,904.1	693.8	493.4	9,420.6	3,547.6
1934	3,879.3	3,601.6	1,228.2	503.6	9,421.7	3,526.8
1935	3,751.4	3,303.1	1,652.4	504.4	9,420.3	3,529.2
1936	3,370.7	3,223.2	2,137.5	529.5	9,437.1	3,501.3

Applying Bitumen—Second Application.

state requires refinery inspection by state inspectors, from crude petroleum to finished road oil from selected fields.

A new road as ordinarily taken over from the contractor needs little grading or shaping up. Under these conditions, an average road oiling job costs about $1,200 per mile and uses about one car of oil. This makes the cost of the oil a little under half of the total, the remainder going for heating, distributing, and road mixing.

Of the cost of the oil—about $750 per car—approximately half is freight, so that about $915 per mile is spent on oiling exclusive of the refinery price.

They have tried to make their specifications as rigid as possible, but most oil experts will agree that there still can be a vast difference in the life of oils obtained under any present day specifications.

Colorado's engineers heartily endorse the national movement now under way to devise a test to determine the lasting quality of asphaltic products, and they hope that when they have completed their own laboratory they will be able to assist in this movement in every way possible.

Colorado's specifications on road oils follow largely the scheme outlined by the Bureau of Public Roads in their various district meetings. They also use the Oliensis Spot test. This is a test of uniformity of the oil and probably detects any cracking process used in refining. No great claims are made by the author of this test, but it has been adopted by several states and the bureau in this district because it has been the best quality test devised.

They also use the low temperature ductility test as well as ductility at 77° F. This also is supposed to raise the quality requirements. They will be allowed to use this specification in Federal Aid work if they reduce the speed of the ductility machine.

Construction Procedures

The first step in oiling a fairly new graveled surface is to windrow enough material from the roadbed to form 2½ in. of loose mixed surfacing. Five heavy motor graders working in series scarify the surface to a width of 22 ft. on the average. The scarified ma-

Cutting Bitumen into Aggregate and Starting Mixing Operation.

Heavy Motor Graders Move Windrows Back and Forth Four or Five Times, as Required.

terial is pushed over toward one side of the road and left by the blade of each machine so that the wheels roll over the lumps to disintegrate them. Two lighter motor graders follow and spread the windrow out to a width of 12 ft. This is then shot by the distributor. Only one third of the quantity of bitumen required is applied at each application. Directly following the distributor is a tractor-drawn disc that cuts the oil into the loose gravel. Two lighter weight 10 ft. motor graders sometimes assisted by one large machine follow the disc and push the oiled mass into a windrow to one side of the road. Five dual-drive 10 ft. motor graders, in series, then work the material from the side windrow to the middle and back again. Motor grader No. 1 straddles the windrow and pushes a part of the roll a few feet. Motor grader No. 2 picks up the roll left by No. 1 and moves it a few feet farther toward the center. Motor grader No. 3 follows directly in the path of No. 2 and cleans the mass down to the subgrade, pushing it to the center. Unit No. 4 picks up the last of the original windrow and rolls it toward the center. Unit No. 5 pushes this roll on top the windrow now created in the center of the road. This is spread out again by the finishing graders so the distributor can make its second application. Windrowing and mixing is continued until three applications of bitumen are made. Specified quantities of SC-3 bitumen are regulated by a knowledge of the aggregate gradation and experience with the work. Depending upon the temperature, usually four to six trips by the motor graders are required to mix the mass. The finishing motor graders then spread out the mixed windrow to a 22 foot width or as required.

On the more heavily traveled roads, 24 ft. is surfaced. Traffic is allowed immediately and the 2½ in. loose depth is compacted by it to 1½ in. Finishing graders work the surface until all fines are out and then they trim the shoulders. After the shoulders are trimmed the coarse stones from the surface are pushed to the edge.

Seal coat is applied after a few days. Sand is stocked in piles along the edge of the surface. The distributor shoots about one-tenth of a gallon of R. C. asphalt on the traffic-compacted surface and the finishing motor

Disc is also used to cut up Remaining Clods.

TABLE I—CONSTRUCTION COSTS OF SOME 1936 ROADMIX BITUMINOUS SURFACES

	GENERAL				COST PER MILE								
Proj. No.	Length Miles	Width Ft.	Thick-ness, In.	Gal. Oil per Sq. Yd.	Oil	Labor	Tools and Equipment Rental	Blades	Overhead & Overhaul	Adding Gravel	Adding Fines	Stockpiles	Seal Coat Tot. Gal.
519-O	53.281	20	1.5	1.23	$1,120.08	$648.27	$384.03	$ 6.21	$ 4.61	$138.10	.....	$ 28.88	126,036
637C-O	10.32	20	1.5	.778	476.05	223.58	80.88	3.43	36.72	22.38	$ 31.53	.....	.....
637-O	9.815	20	1.5	.965	591.88	235.32	123.84	5.16	38.61	.....	63.98	95.63	.....
882-O	4.3	20	1.5	(1)	479.53	203.30	86.88	.....	44.07	.....	.....	107.18	.....
880-O	17.865	20	1.5	(2)	301.75	94.79	57.43	6.46	31.82	139.94	.....	.....	13,308
878-O	6.551	20	1.5	.907	576.47	258.72	124.99	11.28	34.71	84.77	.....	.....	11.160
881-O	5.954	20	1.5	1.023	657.02	133.42	127.47	19.91	38.19	14.20	45.33	.....	.....
637B-O	10.1	20	1.5	.795	483.28	200.58	92.37	3.51	41.27	15.75	84.22	.....	.....
879-O	12.495	20	1.5	1.01	640.85	169.27	115.30	4.87	39.43	129.75	.....	.....	.....
689-O	9.035	20	1.5	1.00+	656.15	231.57	139.77	14.84	41.94	121.68	62.43	165.79	15,405
895-O	3.4	18	1.5	1.1	890.54	218.66	136.38	.....	3.61	572.98	.....	.....	6,225
607-O	10.708	20	1.5	1.24	1,102.60	845.83	629.60	3.78	3.82	.....	.....	52.01	12,890
523-O	5.2	20	1.5	1.05	942.76	128.32	56.71	.....	3.93	561.60	.....	196.58	9,573
548-O	7.531	20	1.25	.876	638.93	269.11	169.94	4.47	42.64	750.49	.....	31.20	.....
893A-O	.957(5)	32	3.0	2.207	2,161.33	974.63	581.53	.....	42.02	.....	.....	.....	.....
874A	2.29	20	2.0	1.25	779.81	465.08	310.69	.....	42.65	.....	.....	36.03	4,286
562-O	1.545	20	1.0	1.00(6)	731.02	398.08	355.80	93.46	42.57	.....	.....	.....	.....
598-O	12.25	20	1.5 to 2.5	1.23 to 1.656	921.46	332.62	250.34	7.85	42.64	.....	.....	25.71	.....
827A-O	(7)	22	1.5	1.04	720.99	335.20	113.63	.....	42.66	117.95	.....	37.68	12,672
829-O	7.7	20	1.0	.772	476.22	348.78	207.66	6.75	42.63	91.64	.....	19.68	10,984
892-O	.05	18	0.5	.474	350.00	195.20	96.74	.....	.....	160.00	.....	.....	.....
898-O	(8)	20-30	1.5	1.038	903.35	957.97	438.25	.....	.....	951.87	.....	.....	.....
614A-O	27.0	24	2.5	1.37	1,201.22	158.26	201.54	13.64	17.69	611.83	52.44	151.68	50,402
870-O	5.0	22	2.5	1.17	1,031.40	341.94	355.11	.....	19.11	481.73	.....	106.50	11,073
866B-O	10.5	20	2.5	1.26	1,003.58	199.93	305.84	.....	17.14	527.18	.....	80.11	18,875
889-O	2.066	20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10,124
866A-O	7.541	20	2.0	1.33	961.40	347.74	212.15	.....	17.95	.....	518.34	106.36	4,024
888-O	16.114	20	2.0	1.21	983.53	279.78	212.06	.....	17.79	518.97	.....	208.80	.....
614-O	11.853	22	2.5	1.237	1,091.76	200.70	214.20	.....	18.81	.....	458.57	159.63	42,631
866-O	9.5	24	2.0	1.26+	1,234.56	178.52	152.32	.....	18.44	.....	234.84	.....	3,051

TABLE I—CONTINUED

Cost Per Mile					
Seal Coat	Water	Demurrage	Coal or Distillate	Testing	Grand Total
$290.35	—	—	$ 7.18	$ 8.66	$2,636.41
—	—	—	4.81	2.88	882.26
—	—	—	11.76	1.01	1,167.18
—	—	—	1.86	3.45	926.27(1)
95.89	—	—	3.68	.91	732.60(2)
219.81	$11.45	—	5.01	—	1,327.21
—	11.76	$5.46	9.45	—	1,062.20
—	—	—	2.41	8.33	931.72
—	—	—	6.11	5.56	1,240.87
219.81	11.07	—	5.60	11.37	1,682.02(3)
229.74	—	—	—	4.37	2,056.28
173.01	—	—	9.47	1.56	2,821.67
249.97	—	—	—	5.48	2,145.35(4)
—	—	—	24.47	8.01	1,939.26
—	—	—	40.96	26.33	3,826.79(5)
251.25	—	—	24.15	15.83	1,925.49
—	—	—	13.01	18.35	1,652.28(6)
—	—	—	14.77	11.02	1,606.43
785.27	—	—	10.05	10.93	2,174.36(7)
295.04	—	—	9.97	9.17	1,507.53
—	—	—	—	—	801.94
—	—	—	25.67	24.17	3,301.27(8)
176.33	—	—	29.74	9.65	2,624.02
194.34	—	—	25.28	4.59	2,559.99
255.85	—	—	18.41	8.35	2,416.39
786.86	—	—	—	—	786.86(9)
70.84	—	—	13.26	9.67	2,257.71
—	0.54	—	6.38	7.41	2,182.62
335.75	—	—	7.13	20.39	2,506.92
23.37	—	—	13.87	1.04	1,856.97

(1) 1,682 mi. new oiling, 2,618 mi. reconditioned.
(2) 7,793 mi. new oiling, 10,072 mi. reconditioned.
(3) Reconditioned and new oil.
(4) 4.7 mi. new oiling, 0.5 mi. reconditioned.
(5) 18,200 sq. yds.
(6) 1,545 mi. new oiling, 0.9 mi. reconditioning, 1.00 gal. per sq. yd. on new and 0.366 on reconditioning.
(7) 2.8 mi. new oiling, 7.2 mi. seal coat.
(8) 9,700 sq. yds. in 0.6 mi.
(9) Seal coat job only.

graders spread sand over this application. The sand blots up the bitumen and a very smooth driving surface results.

Outfit

Each of the seven districts has a complete outfit. The one working just north of Denver consisted of the following: One small Cletrac tractor, with gang disc; two 10-ft. lighter weight motor graders, an Austin-Western junior and a Caterpillar 10; one 5-ton White motor truck mounted with a 1000 gal. Etnyre distributor; one 3½ ton Jarrett truck with a 1000 gal. supply tank mounted on it and drawing two 1000 gal. tank trailers; one Cleaver-Brooks tank car heater; two light utility trucks; and five Austin-Western 10-ft. dual drive motor graders. Mr. C. H. Draney is the Oiling Foreman of this district. Construction is under the direct supervision of D. N. Stewart, Superintendent of Maintenance.

The average output of all seven crews last year was 0.73 miles completed surface per day including breakdowns, delays, rainy weather and all. Table I gives the costs on some of last year's work.

The following table is a typical job construction report:

CONSTRUCTION REPORT

Project No. *866 B-O*
Length *10.5* miles
On S. H. No. 10 from *Walsenburg* to *La Veta, Huerfano* County
Foreman *Paul Green*
Date Started *July 9, 1936.* Date Finished *July 26, 1936*
Type *Roadmix* Width *20 ft.* Thickness *2½* inches
Kind of Oil *SC-3* Furnished by *Texas Company (Port Neches)*
Total gals. of oil used *155,339* @ *$.06783* per Gal. Total *$10,537.60*
Gallons of Oil per Sq. Yd. *1.26*
Equipment Rental *$862.35* Overhead, Including Overhaul *$179.92*
Repairs, Small Tools *$1,082.92*
Gas, Kerosene, Lubricating Oil, Grease, etc. *$1,225.25*

COSTS

	Total Costs	Cost Per Mile
1. Cost of Oil	*$10,537.60*	*$1,003.58*
2. Cost of all labor for Preparation, Oiling and Processing	*2,099.31*	*199.93*
3. Cost of Small Tools, Equipment Rent, Operation and Repairs, Less Labor for Operation	*3,211.35*	*305.84*
4. Cost of Blades	———	———
5. Cost of Overhead, Including Overhaul	*179.92*	*17.14*
6. Cost of Adding Gravel	*5,535.39*	*527.18*
7. Cost of Adding Fines	———	———

Loading Shuttle Truck and Trailers at Car Siding at East Lake, Colorado.

8.	Cost of Stockpiles			
	Gravel ———	———		
	—— Gals. Oil ———	———		
	Dept. Equipt. ———	———		
	All Other Costs ———	———	*841.16*	*80.11*
9.	Seal Coating			
	18875 Gals. *RC-4* Oil @ *$.07873*	*$1,486.12*		
	—— Tons cover coat	*883.81*		
	Department Equipment	———		
	All Other Costs	*316.50*	*2,686.43*	*255.85*
10.	Cost of Water		———	———
11.	Cost of Demurrage		———	———
12.	Cost of Coal or Distillate		*193.30*	*18.41*
13.	Cost of Testing		*87.65*	*8.35*
14.	Grand Totals		$25,372.11	$2,416.39

It will be noted that no entry is made for cost of blades. This cost runs about $10.00 per mile and is probably included in Item 3.

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Disregard of Signs Is Accident Cause

Several weeks ago the Indiana Highway Commission established a Bureau of Traffic to study traffic problems on the state highway system and promote greater motoring safety. A recent survey by the Bureau shows that at one intersection where there have been several accidents and deaths, less than half of the drivers came to a complete stop before entering the intersection. More than 50 percent of the drivers disregarded or only partially obeyed the "Stop" sign placed some distance back from the intersection.

Some of the drivers who did not bring their vehicles to a full stop, entered the intersection at low speeds and could have stopped in case of an emergency but 10 percent of the traffic entered the intersection with no regard for the stop sign and at too fast a speed to have stopped in any emergency. It is this class of drivers, disregarding caution and stop signs along the highways, that is responsible for a majority of the accidents reported almost daily, the Bureau of Traffic survey discloses.

Accidents occur most frequently at places on the highways where the danger is not readily apparent and it is at such places that the caution and warning signs erected by the highway commission are most valuable. There are comparatively few accidents at points where the danger is obvious to the driver without the presence of warning signs.

In addition to its study of accidents on the state highway system, the Bureau of Traffic is engaged in a survey of the hazards created by parked vehicles close to intersections and other places along the highways. In some cases vehicles parked just off the traveled part of the highways have obstructed the vision of other traffic, creating an unnecessary hazard.

Where such practices have been reported, investigations are being made and the Bureau of Traffic is recommending the establishment of "No Parking" zones near intersections and other dangerous places.

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Skyline Drive Nears Completion

Construction now in progress on 21 miles of road on the Skyline Drive just south of Swift Run Gap, Virginia, leaves only 9 miles of this scenic route to be put under contract. Plans for this last section, just to the north of Jarman's Gap, have been completed by the U. S. Bureau of Public Roads which is directing the work for the National Park Service.

The Drive—from its northern end at Front Royal, to Jarman's Gap—is 96 miles long. The section already completed from Front Royal to Swift Run Gap has attracted thousands of tourists from all parts of the East.

The Skyline Drive is being extended to the Great Smoky Mountains National Park in North Carolina and Tennessee by the Blue Ridge Parkway, 460 miles in length.

Thirty miles of this parkway have been graded and surfaced with crushed stone but are not yet open to the public. Construction is in progress on an additional 104 miles on other sections of the parkway.

Tar Soil Stabilization in South Carolina. Unstabilized Section in Background.

SOIL STABILIZATION WITH TAR

BY GEO. E. MARTIN
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DIG into any road and you will find soil. It may be on the surface as in the earth road or far underneath where a concrete, macadam or gravel foundation has been built. In any case, it is the soil which must support the weight of the traffic. Foundations assist the soil in this job by spreading the weight over a large area and reducing the unit pressure on the soil. Most of our highway construction has been along that line. Only a few attempts have been made until recently, to increase the supporting power of the soil itself. Many of the modern stabilization projects have had as their object the improvement of the gravel foundation rather than the soil itself.

Tars have been used in the stabilization of gravel and sand roads for a number of years. Tar gravel surface treatments, which date back to 1912, are a type of stabilization where the tar is permitted to penetrate into the gravel surface. The mulch treatment of gravel and sand roads introduced the mixed-in-place process about 1920, and the tar was mixed with the existing aggregate on the road as a binding and water-proofing agent. The use of tars for improving natural soils is the next logical step.

Scarifying Soil.

Natural Soil.—The soil as found in the road will vary in bearing power with its composition and moisture content. In composition it may vary from almost pure clay to practically all sand. In general, clay soils are most stable when dry and sands have the best bearing power when wet or damp. Wet clay soil is unstable and dry sand has little supporting value unless confined. It is, of course, impossible to control moisture content in a road. If, however, something can be added to the soil which will modify the clay and make it resistant to water action, the heavy clay soils can be stabilized and their bearing power increased. Tar does have this effect and can also be used as the binding agent for sands.

Tar For Stabilization.—Tar itself is not affected by water even though exposed to its action continuously for long periods of time. The stabilizing action of the tar is not confined to a short period of time following the application of the tar, but may be considered to be practically permanent. Tar is easily mixed with finely divided material and may also be readily mixed with damp or wet soil. The clay particles are coated with the tar film and thus made water resisting, although still retaining their binding properties. The tar itself, being heavier than water, is not easily displaced by the action of water.

Soil Mortar.—The soil material passing a No. 10 sieve is combined with the tar to form a soil mortar. Where clay is present the active binding agent will be the material passing a No. 200 sieve. The amount and character of this material will determine the type and amount of tar necessary for stabilization. The exact answer for any particular project is determined by a laboratory investigation of the soil. A heavy clay soil will require a comparatively large amount of tar for

Blading Soil in Windrow.

stabilization and it may be more economical to add sand to the soil and thus reduce the amount of tar needed. On the other hand, some sands may require considerable tar for stabilization and the work may be cheapened and improved by the addition of clay. The mixture of soil, tar and added sand or clay will form the soil mortar.

Type of Tar.—The best type or consistency of tar to use will depend upon the amount of natural clay binder present in the soil. Very heavy clay soils are more easily mixed with light tars. Here also the clay is the binder and tar is only needed to modify the clay and make it water resisting. Light tars ranging in Engler specific viscosity at 40° C. from 5 to 35 are commonly used. As the soils become more sandy, more binding properties are required of the tar and heavier tars are used. Medium tars ranging in Engler specific viscosity at 50° C. from 17 to 40 are utilized. Tars in the upper portion of this range are also used with sand where the tar is almost the sole binding medium.

Applying Tar.

Even hot surface treatment tars with a float test at 32° C. of 50 to 80 seconds are used in sections where high air temperatures prevail.

The choice of the tar consistency, therefor, depends largely upon the amount of material passing a No. 200 sieve in the soil mortar. There is considerable leeway in this choice since experience has shown that, with the same soil, satisfactory results will be obtained with tars which vary somewhat in consistency. Exact tar consistency is evidently not an important factor.

Amount of Tar.—The amount of tar needed will depend upon the character and amount of material passing the No. 200 sieve. A heavy clay soil, containing almost no sand, may require as much as 15 percent of tar by weight to coat the clay particles. A sand containing almost no clay may also require up to 8 percent of tar to satisfactorily bind the sand particles together. A mixture of sand and clay may require a much lower percentage of tar. In the light of present knowledge it looks like efficient stabilization can be done with two percent or less of tar. For a 4 in. depth, 2 percent would be about a gallon of tar per square yard.

Mixing Tar and Soil.

Soil Concrete.—The soil mortar can be used as a foundation without the addition of aggregate. However, the use of aggregate retained on the No. 10 sieve may materially reduce the cost of the project. Added aggregate will, of course, reduce the amount of soil mortar per square yard. However, there must be sufficient soil mortar present to entirely fill the voids in the coarse aggregate. Additional or excess soil mortar will do no harm, although it may make the project more costly than necessary.

The following example illustrates how the soil concrete is designed. The soil on this project, as obtained from the road, showed the following gradation:

Passing 1 in. sieve.....100 percent
Passing No. 10 sieve.....80 percent

The material above the No. 10 sieve is the coarse aggregate and that passing is the fine aggregate for the soil mortar. Of this material passing the No. 10 sieve, 20 percent passed the No. 200 sieve. A laboratory investigation showed that 2 percent of tar with an Engler specific viscosity at 40° C. of 22 to 25 would be needed for stabilization. The fine aggregate weighs 125 lbs.

Tar in Place on Road.

per cubic foot, so a 4 in. depth would weigh 375 lbs. per square yard. Two percent of tar would be 7.5 lbs., or about 0.8 gal. per square yard. However, only 80 percent of the soil is soil mortar so that the tar required per square yard would be 0.64 gal. However, road mixing is not as efficient as laboratory mixing and a slight excess should be provided and the amount to be used is set at 0.75 gal. per square yard.

Optimum Moisture Content.—For each soil there is but one moisture content at which the maximum density is produced by a specific degree of compacting. This moisture content is called the optimum moisture content. Sufficient tar will not be used in most cases to produce this result and water must be added. The amount needed will vary with the soil type. In the example cited above the optimum moisture content for the fine aggregate was 10 percent which would require about 3.5 gals. of water per square yard, allowing for the effect of the tar and for the coarse aggregate. The road should contain this moisture content at the time of compaction.

Having designed the soil concrete we may now proceed to manufacture it on the road.

Preliminary Preparation.—Drainage is an essential element in the production of a satisfactory stabilized base. The necessary drainage structures should be installed to insure a thoroughly drained sub-base.

The area to be stabilized should be scarified to sufficient depth to furnish stabilized material of the desired thickness after compaction. The material on the road should be mixed with a disc harrow or similar machine to break any lumps of clay and distribute them throughout the mass. If additional aggregate is to be placed on the road it may be added at this time.

A heavy clay soil, requiring a high percentage of tar, will not need much water. Best practice seems to be to mix the tar and the soil and add the small amount of water just prior to compaction. Sand will not require any water in most cases, and the soil mortar can be satisfactorily compacted after the tar has been ap-

Tamping With Sheep's Foot Roller.

Spreading Tar-Soil Mixture.

plied and mixed. Intermediate soils may have the necessary water to produce the optimum moisture content applied to the soil before the tar is applied. This will aid in obtaining a more thorough mixture of the tar and soils of this type.

If there is sufficient width the soil should be bladed into a windrow on each side of the road. On narrow roads it may be necessary to windrow the material on one side of the road, and do one side at a time.

Applying the Tar.—Mixing will be facilitated by applying the tar to successive layers of prepared soil. The soil is spread over the sub-grade in a layer from 1 to 2 in. in depth, and the tar applied on the top of the layer. Additional soil is then bladed over the tar and an additional application of tar made on the top of this layer. The operation is repeated until all of the soil and the required amount of tar are on the roadway.

Mixing.—Mixing the tar and soil may be accomplished by means of harrows or other road mixing machines. Various machines have been designed for this

Final Rolling.

purpose, and as thorough a mixture as possible of the tar and soil should be obtained. Probably no mixing apparatus will entirely coat the clay particles with tar but the natural wetting properties of the tar will produce this result in time. The mixing operation places the tar and soil particles close together so that nature may finish the job.

Consolidating.—In order to obtain the best results the soil concrete must be thoroughly consolidated. Finely divided soils which do not contain sufficient granular material to provide for mechanical interlocking should be consolidated from the bottom up. The ordinary flat wheel roller will form a consolidated crust on the top and the material underneath will still be loose. A sheep's foot roller will do a good job and perhaps some form of tamping machine would be even better. Traffic, if sufficiently heavy, can be used for consolidation. An efficient machine consists of a frame with several truck wheels, mounted side-by-side on the front axle and truck wheels mounted on the rear axle staggered so that they travel in the space between the wheels on the front axle. This machine can be loaded to any desired weight, and pulled by a tractor.

After the road is compacted in this manner it should be shaped with a blade grader and finished with a flat wheel roller.

This completes the stabilized foundation and the road may be opened to traffic.

Traffic Resisting Surface.—Stabilization will produce foundations satisfactory for supporting the weight of traffic but usually these foundations must have some sort of top to resist the abrasive action of traffic and form a waterproof surface. This top may be placed immediately or the road may be subjected to traffic for a short time before the top is built.

The first step in the construction of the top will be the application of a prime coat of light tar at the rate of approximately ¼ gal. per square yard. This prime coat is permitted to penetrate into the road surface, and usually will not be covered with aggregate. The next step may be a surface treatment with hot tar or the construction of a mulch or re-tread surface.

Results.—The construction of a stabilized base will result in the relative improvement of the road. It may not entirely solve the problem since even the stabilized base may not be strong enough to carry the traffic over the entire road length. However, additional strength can always be added by increasing the depth of the top and the material used in the base is not lost.

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What Would Joliet Have Said?

Louis Joliet was a man who met the needs of his time and environment, and we may safely believe would have given a hearty "Oke" (or should it be "Très bien"?) had he been among the American Steel and Wire Company's two hundred guests at the June 23 opening of its twin rod mills in the city bearing his name. For men who achieve have a common spirit, whether exploring rivers in the seventeenth century or developing industries in the twentieth; and in that spirit, old Joliet and today's mill builders could meet understandingly.

The new rod mill, costing about $3,000,000 (the major part of a $5,000,000 development including improvements in the company's billet and wire mills) is devoted exclusively to the production of rods to be used in the manufacture of wire. Steel for the purpose is received in the form of 2 5/16 in. square billets 30 ft. long. After heating, it passes through a set of 19 rolls to the reels where it is wound into coils for shipment to the wire mills. The bulk of the product is a rod of 0.207 in. diameter. This comes off the final pass at a speed of 3,428 ft. per minute, or approximately 40 miles an hour, as compared to 1,500 ft. per minute in the old Joliet mills.

Such speed is made possible by the use of anti-friction bearings throughout the plant; and by practically eliminating temperature drop in the rod during rolling gives a precision and uniformity of product exceeding any previous.

The company's hospitality was in keeping with its mill standards. A special train took the Chicago guests to Joliet, where they were received and entertained at luncheon by the Joliet Association of Commerce. Then home town folks and visitors went to the plant, where they were given a complete view and explanation of operations. On the return to Chicago there was further entertainment and dinner at the Union League Club.

Messers C. F. Blackmer, President, C. F. Hood, Executive Vice President, and other officials represented the American Steel and Wire Company, as hosts.

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Timber Used in Divided Highway

Plans of the State Division of Highways of California for 90 miles of 4-lane highway, supplementing 55 miles already in use, utilize structural redwood in various localities in providing a divided highway.

Designed for immediate construction on the difficult Altamont Pass, between Oakland and Stockton on U.S. No. 50, will be 12 miles of 4-lane highway, using a 4 ft. island with redwood curbs. Redwood was also used in the curbing on the new Cuesta Grade alignment in San Luis Obispo county on Highway No. 101 and on the divided highway approaches in Alameda county to the San Francisco-Oakland Bay Bridge.

MANUFACTURE AND USE OF PORTLAND CEMENT

Part III—Recent Trends in Manufacture, Testing and Specification Writing

By EDWARD E. BAUER

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IN the two previous articles it was pointed out that portland cement is made from two materials; one supplies lime (CaO) and the other clay or shale $Al_2O_3.SiO_2$ being the main constituent. These raw materials are pulverized to a fine degree, mixed in proper proportions, burned to incipient fusion, and then ground to a very fine degree. In the burning process four major compounds appear to be formed: tricalcium silicate, dicalcium silicate, tricalcium aluminate, and tetracalcium aluminoferrite. The first two are the important ones for the development of strength, the tricalcium silicate hydrating rapidly and the dicalcium silicate more slowly. When water is mixed with the cement a calcium silicate gel is formed which hardens with age and thus binds the mass of aggregate together. In this article will be presented recent trends in manufacture, testing and specification writing.

Fineness of Grinding

Portland cements are ground to a relatively fine degree. In the early specifications (until 1917) not more than 8 per cent could be retained on the No. 100 sieve and not more than 25 per cent on the No. 200 sieve. Since 1917 the only requirement has been that not more than 22 per cent be retained on the No. 200 sieve. The No. 200 sieve is one having 200 openings per linear inch or 40,000 per square inch, the wires being included in the dimensions given.

The trend has been for the manufacturers to grind the cements finer and finer until in some cases practically all the cement will go through the No. 200 sieve. Studies have indicated that the cement is a graded material, the same as the aggregate, and that specifying merely a top size, or that the particle size accumulation curve should pass between certain limits for the No. 200 sieve, is not entirely satisfactory. No one, for instance, would think of making the only requirement for sand that 95 to 100 per cent should pass the No. 4 sieve. So it has been reasoned that that practice should not be followed for portland cement.

Since portland cement is practically all finer than the openings of the No. 200 sieve, and that is about as fine as it is practical to make sieves, other means must be used to arrive at particle sizes. Tiny spherical particles of any material fall at a uniform velocity through a liquid according to the diameter of the particle. Practical use of this idea is made in the Wagner *turbidimeter*[1] which is coming into general use now to control the fineness of grinding.

Turbidimeter Test

In the turbidimeter test,[2] a small sample of cement is dispersed in a liquid such as kerosene, which does not react with the cement. As soon as agitation stops the cement begins to settle, the suspension at the bottom becoming more dense while that at the top is becoming less dense. A beam of light is passed through the suspension at some depth below the surface at various intervals of time, and the resistance of the suspension to the passage of the light is a measure of the density of the suspension. The denser the suspension at any reading, the higher is the percentage of fine particles, because they would have settled out sooner had the particles been larger. By proper correlation between the resistance of the suspension to the passage of the light, the percentages of particles smaller than certain diameters can be computed.

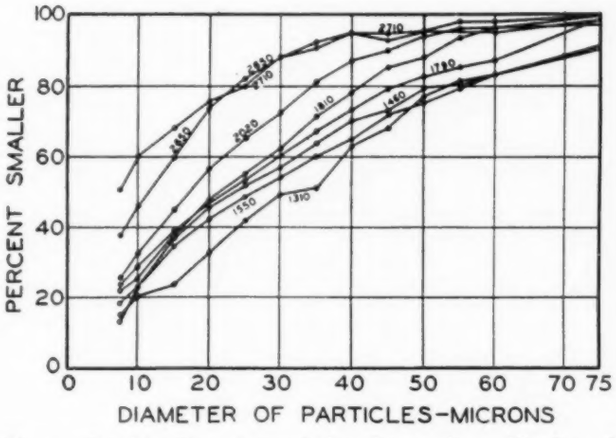


Fig. 1.—Particle Size Accumulation Curves for a Number of Portland Cements.[3]

Specific Surface Value

Instead of specifying certain limits for a number of different diameters as is done in the case of aggregates, a function, known as specific surface, has been worked out. The area of the surface of the particles in one gram of cement is calculated assuming the particles are spheres. The area is given in square centimeters. Since the finer particles contribute a greater surface area per unit of weight, the higher specific surface values indicate finer cements. Specific surface values of most cements today lie between 1500 and 2000 sq. cm./g. In the English system, these values would be 68,900 sq. ft. and 91,900 sq. ft. per sack of 94 lb.

In Fig. 1 is plotted some particle size accumulation curves for cements having various values of specific surface.[3] These curves are similar to the sieve analysis curves for aggregates, which are familiar to all engineers. One microm is 0.001 mm. or 0.00003937 in. It is much easier to use this unit than decimals of either inches or millimeters. In the case of all the cements shown in Fig. 1, 90 per cent pass the No. 200 sieve, yet there is a wide difference in the range of values for the smaller sizes.

In the 1936 revision of the A. S. T. M. specification for high-early-strength-cement, the sieving requirement was omitted and the new specific surface function substituted. The minimum specific surface value must be 1900 sq. cm./g.[4] The new government specifications (see Table III) give the newer function and it appears as only a matter of time until the A.S.T.M. will include specific surface as a requirement for the standard grade of cement.

It has long been realized that increasing the fineness of grinding of cement will improve the strength developing characteristics,[5] especially at the early ages. Since it is the hydrated calcium silicates that are the strength giving compounds, it is logical to assume that these compounds can become hydrated more rapidly if they are ground finer. Manufacturers are, therefore, grinding their cements finer in order to secure greater early strengths, something which seems to be demanded by the construction industry.

It should be borne in mind in comparing several cements that degree of fineness of grinding is no exact measure of the amount of early strength to be developed. For any given mixture of raw materials the finer the grinding, the greater will be the strength of the mortar or concrete in which it is used.

Effect on Strength

A study of test results from preliminary investigation in connection with the Passamaquoddy project[3] indicate that the 28-day mortar compression strengths increase with higher values of specific surface for cements of relatively the same compound composition. The cements compared had the following range of composition:

tricalcium silicate	48-53 per cent
dicalcium silicate	22-29 per cent
tricalcium aluminate	4.6-9.3 per cent
tetracalcium aluminoferrite	8.5-15.2 per cent

Strengths secured were:

Specific surface sq. cm./g.	28-day Compression strength p.s.i.
1460	2655
1550	3405
1650	3475
1790	3915
1810	4325
1890	4485
1980	5467
2020	6085

Strength

There has been a gradual improvement in the strength developing ability of cements over a long period of time. There has always been a tensile strength requirement in the A.S.T.M. specifications for portland cement. In this test the cement is mixed with standard Ottawa sand (pure quartz sand sieved to pass No. 20 sieve and be caught on the No. 30 sieve), 1 part cement to 3 parts sand. This mortar is packed into briquet molds. The briquets are tested at 7 and 28 days. Changes in the minimum A.S.T.M. requirements are given in Table I.

TABLE I.—TABULATION OF MINIMUM A.S.T.M. TENSILE STRENGTH REQUIREMENTS FOR PORTLAND CEMENT

Year of Adoption	Tensile Strength, 1:3 S.O.S. Mortar 7 days	28 days
1904*	150-200	200-300
1909	200	275
1916	200	300
1926	225	325
1930	275	350

*Purchaser to set his own minimum value which was to be within the limits given above.

The increase in requirements has generally followed, rather than preceded, the necessary improvement in the cement by the manufacturer.

Proposed Strength Test

A compressive strength test for use in controlling the quality of portland cement has been under consideration for some time. In 1916 a tentative method of test[6] was proposed using the same mortar as in the tensile-strength test, in a 2-x4-in. cylindrical specimen. Minimum strength values set were 1200 p.s.i. at 7 days and 2000 p.s.i. at 28 days. This test was never added to the standard specifications and was finally withdrawn in 1932.[7]

In 1934 the A.S.T.M. adopted a new tentative method of making a compressive strength test on portland cement.[8] In this procedure the test specimen is a 2-in. cube. The mortar is made 1 part of cement, 2.77 parts of graded Ottawa sand, and 0.53 part of water, all on a weight basis.

The compressive strength requirement has not been written into the A.S.T.M. specification for standard portland cement (this is being written prior to the 1937 meeting) but in 1936 the use of either the tensile or compressive strength requirement was optional with the purchaser. Minimum compressive strengths specified are 1300 p.s.i. at 1 day and 3000 p.s.i. at 3 days.[8]

New Water-Cement Ratio—Strength Curve

Abrams, in 1918, published[9] the well-known curve showing the relationship between water-cement ratio and compressive strength, the formula being $S = \frac{14000}{7^x}$ in which

S=compressive strength, p.s.i.
X=water-cement ratio

Tests made by the writer at the University of Illinois during the period 1934 to 1936 indicate that a safe formula to use now is[10] $S = \frac{14000}{4^x}$

The two curves are shown in Fig. 2 and the data on which the new curve is based are shown in Table II. The

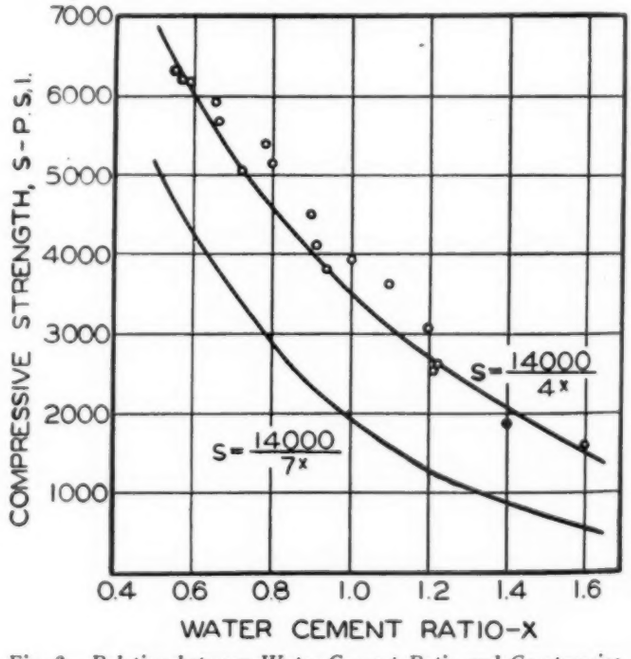


Fig. 2.—Relation between Water-Cement Ratio and Compressive Strength, Showing the Original Curve (lower) Published by Abrams[9] and the New One Suggested by the Writer.[10]

TABLE II.—DATA CONCERNING PRESENT DAY RELATIONSHIP BETWEEN WATER-CEMENT RATIO AND COMPRESSIVE STRENGTH

Standard portland cements used in all tests.
Tests made on 6 in. x 12 in. cylinders.
Cylinders remained in the molds in laboratory air approximately 24 hours, after which they were placed in a moist room at approximately 70°F. Tests were made at 28 days and immediately following removal from moist room.

Water-cement ratio	Strength p.s.i.	Number of Cylinders
0.56	6380	3
0.58	6240	21
0.59	6230	3
0.66	5950	21
0.67	5740	3
0.724	5090	3
0.79	5450	6
0.80	5190	27
0.90	4525	180
0.91	4190	21
0.94	3860	3
1.00	3960	33
1.1	3680	33
1.2	3100	33
1.22	2580	3
1.25	2650	18
1.40	1910*	15
1.60	1630**	30

*All very wet batches which might well be classed as unworkable.
**Concrete for this water-cement ratio was very lean (1:4:8) and as a result the strengths varied a great deal. All values available were averaged in this case.

variable number of cylinders used in computing the averages is due to the fact that they were made in varying numbers. In figuring average values, any value not within 10 per cent of the average was eliminated.

A comparison of the two curves of Fig. 2 indicate that standard cements of today produce concrete that is about 75 per cent stronger at 28 days than did the cement of the period 1915-18.

It should be borne in mind that the strength on which the new curve is based were secured in the laboratory under controlled conditions, and even though all the points considered in establishing the curve are on or above the curve, it is possible for conditions on the job to be such as to produce lower strengths.

Classifications of Cement

The American Society for Testing Materials has specifications for three different classes of cement: (1) standard portland cement;[11] (2) high-early-strength portland cement;[4] and (3) natural cement.[12] The United States government recently issued specifications for four types of cement:[13] (1) standard portland; (2) high-early-strength portland; (3) moderate heat; and (4) sulphate resisting. A low-heat cement was used in the construction of Boulder Dam, but its use has not been required in other dams built by the Bureau of Reclamation, nor in those built by the Tenessee Valley Authority. A low-heat cement was at first included in the group of cements for which specifications were prepared recently by the United States government, but was finally omitted.[13] Research is being carried on concerning the possibilities of puzzolanic-portland cements, but to date the use of such cements has been very limited. A summary of the requirements of the new federal specifications is given in Table III.

Standard Portland Cement—Our discussion has been largely concerning the standard portland cements. Federal requirements are given in Table III and the A.S.T.M. requirements in Table IV.

High-Early-Strength Portland Cement—This is merely a cement which has been manufactured to meet certain strength development characteristics. Normally this is done by: (1) finer grinding, (2) higher tricalcium silicate content, and (3) more careful control of the raw materials. Table 4 gives the A.S.T.M. requirements and Table 3 the new federal values.

Moderate Heat Cement—In order to secure the early strengths demanded of the two preceding cements, the reaction of the calcium silicate compounds must be rapid and with all rapid reactions there is a quick release of heat. In certain types of construction there is a large mass of concrete with little opportunity for the rapid dissipation of this heat, a factor which may be undesirable. In order to keep down the amount of heat developed, the amount of dicalcium silicate is increased somewhat and the amounts of the tricalcium silicate and the tricalcium aluminate decreased. The latter compound is especially high in the development of heat during the first day. The new federal requirements for this type of cement are given in Table III.

Sulphate Resisting—Cements to be used in concrete subjected to sea water or the alkali waters of western United States need to be specially resistant to the action of these salts. The effect of these salts can be minimized by making a very dense concrete which will limit to a very large extent the movement of water within the concrete. Tests indicate that the percentage of tricalcium

TABLE III.—SUMMARY NEW CEMENT SPECIFICATIONS UNITED STATES GOVERNMENT[13]

		Standard Portland Cement	High Early Strength	Moderate Heat	Sulphate Resisting
Loss on Ignition, %		3.0	3.0	3.0	3.0
Insoluble Residue, max. %		0.75	0.75	0.75	0.75
SO_3, max. %		2.0	2.50	2.0	1.75
MgO, max. %		5.0	5.0	5.0	4.0
Al_2O_3, max. %		7.5	7.5	6.0	4.0
Fe_2O_3, max. %		6.0	6.0	6.0	4.0
Tricalcium aluminate, max. %		15.0	15.0	8.0	5.0
Silica, SiO_2, min. %		—	—	21.0	24.0
Ratio $Al_2O_3 \div Fe_2O_3$		—	—	0.7-2.0	0.7-2.0
Fineness, sq. cm./g.		1500 min.	1900 min.	1800 min.	1800 min.
1:3 S. O. S. Mortar Tensile Strengths	1 day	—	275	—	—
	3 days	175	375	125	—
	7 days	275	425	250	175
	28 days	350	—	325	300
Heat of Hydration Cal./g.	7 days	—	—	70	—
	28 days	—	—	80	—
1:2.75 Ottawa sand mortar strengths in compression, p.s.i.	1 day	—	1250	—	—
	3 days	900	2500	750	—
	7 days	1800	3500	1500	1000
	28 days	3000	—	2500	2200

TABLE IV.—A.S.T.M. REQUIREMENTS FOR STANDARD AND HIGH-EARLY-STRENGTH PORTLAND CEMENTS

			Standard	Early-High-Strength
Loss on ignition, per cent maximum			4.00	4.00
Insoluble residue, " " "			0.85	0.85
Sulfuric anhydride, " " "			2.00	2.50
Magnesia (MgO), " " "			5.00	5.00
Fineness, per cent retained on No. 200 sieve, maximum			22.0	
Fineness, specific surface, sq. cm./g, minimum				1900
Soundness, pat must be			sound	sound
Time of setting, hours	Initial	Gillmore	1	1
		Vicot	3/4	3/4
	Final	Gillmore	10	10
		Vicot	10	10
Tensile strengths, pounds	1 day		275	275
	3 days			375
	7 days		275	
	28 days		350	
Compressive strengths, p.s.i.	1 day			1300
	3 days			3000

aluminate must be kept low.[3], [13] The new federal specifications limit the percentage to five, while the tentative specifications on the Quoddy project gave eight per cent as the upper limit.

Puzzolanic Portlands

Puzzolan is a term applied to a siliceous material which in itself has no cementing value, but which, when mixed with lime exhibits cementitious properties. Since there is a small amount of uncombined lime in cement and some more is produced during the hydrating of the calcium silicates, it is felt that there is an advantage in the addition of a small amount of siliceous material which may combine with this lime to form more calcium silicates, which in turn can be transformed into the gel that holds the mass together.[14]

Portland-puzzolan cement was used in the construction of Bonneville Dam; Clark and Brown report as follows concerning its use.[15]

"Portland-puzzolan cement as used at Bonneville has given highly satisfactory results. It seems safe to say that it deserves an increasingly important place among special cements and when used in carefully designed mixes the resulting concrete may be said to have the following advantageous properties:

1. Improved workability.
2. Freedom from segregation and water gain.
3. High factor of impermeability as compared with low heat portland cement.
4. In comparison with modified portland cement a greater percentage of total heat of hydration is developed at early ages and less total heat of hydration.
5. Relatively high early tensile and compressive strength coupled with high early and continued plastic properties.
6. Long continued gain in strength."

Natural Cement—"Natural cement" according to the A.S.T.M. definition,[12] "is the finely pulverized product resulting from the calcination of an argillaceous limestone at a temperature only sufficient to drive off the carbonic acid gas." In the early days of cement production in this country most of it was natural cement but today the quantity is relatively small. Not much strength is developed, the A.S.T.M. requiring only 50 lb. at 7 days and 125 lb. at 28 days in the 1:3 standard Ottawa sand tensile test. Because of the small amount of strength developed it is little used in concrete.

White Portland Cement—The gray color of portland cement is caused largely by the presence of iron oxide in the limestone and shale. Pure calcite limestone and white clay is found in Pennsylvania and two companies produce a white portland cement from these materials. Iron oxide normally is less than 6 per cent in gray portlands while in the white cement it is less than 0.5 per cent. Since the strength developing compounds do not involve iron as one of the chemical elements, white cement can be made to the same requirements as the gray cements.

FOOTNOTES

1. Wagner, "A Rapid Method for the Determination of the Specific Surface of Portland Cement." Proceedings, A.S.T.M., Vol. 33 (1933) Part 2, pp. 553-570.
2. See "Tentative Method of Test for Fineness of Portland Cement by Means of the Turbidimeter." A.S.T.M. Designation: C115-34T.
3. From Casey, "Cement and Concrete Studies on the Passamaquoddy Tidal Power Project." Proceedings, Am. Conc. Inst., Vol. 33 (1937) pp. 279-302.
4. See "Standard Specifications for High-Early-Strength Portland Cement." A.S.T.M. Designation: C74-36.
5. See Abrams, "Effect of Fineness of Cement," Proceedings A.S.T.M., Vol. 19 (1919) Part II.
6. "Tentative Specifications and Tests for Compressive Strength of Portland Cement Mortars." A.S.T.M. Designation: C9-16.
7. See "Report Committee C-1 on Cement," Proceedings A.S.T.M., Vol. 32 (1932) Part I, p. 295.
8. "Tentative Method of Test for Compressive Strength of Portland-Cement Mortars." A.S.T.M. Designation: C109-34T.
9. Abrams, "Design of Concrete Mixtures," Bulletin 1, Structural Materials Research Laboratory, Lewis Institute.
10. See Bauer, *Plain Concrete*, Second Edition (1936).
11. Serial Designation: C9-30.
12. Serial Designation: C10-09.
13. See Moreell, "The Federal Specifications for Portland Cements." Proceedings, Am. Conc. Inst., Vol. 33 (1937) pp. 435-458.
14. Scripture, "The Possibilities of Puzzolans in Mortars and Concretes," *Engineering News-Record*, Vol. 115, pp. 563-7. See also Davis, Carlson, Kelly and Troxel, "Properties of Mortars and Concretes Containing High-Silica Cements." Proceedings, A.C.I., Vol. 30, pp. 369-388; Davis, Kelly, Troxel and Davis, "Properties of Mortars and Concretes Containing Portland-Puzzolan Cements," Proceedings, A.C.I., Vol. 32, pp. 80-114.
15. Clark and Brown, "Portland-Puzzolan Cement as used in the Bonneville Spillway Dam." Proceedings A.C.I., Vol. 33, pp. 183-222.

▼

Traffic Control Plan Based on Sight Distance Studies

The first Michigan traffic control plan based on sight distance studies went into effect July 1 along US-112 in Lenawee County. The zoned area extends 10.3 miles through the Irish Hills section in Woodstock and Cambridge townships.

A 45-mile-an-hour speed limit has been established in this area. Traffic is prohibited from crossing yellow lines at designated locations where sight distances are under 700 ft. State police plan to patrol the area for violations with convictions calling for a $100 fine or ten days in jail or both.

Parking is prohibited adjacent to the road shoulder as another feature. Guard rail is erected 10 to 15 ft. from the shoulder at a dozen locations in the vicinity of filling stations, restaurants, etc. No parking will be allowed between the guard rail and shoulder. Later features will involve the cutting away of banks to improve sight distances, short pavement relocations to eliminate sharp, reverse turns, and possibly traffic lights and night lighting.

There are 24 curves along this route with sight distances of 305 to 775 ft. indicating minimum and maximum speeds of 31 and 55 miles for stopping within a safe distance. The speed limit of 45 miles an hour is actually two miles higher than the average safe-stopping speed. It was felt, however, that a 43-mile-an-hour limit would "unduly penalize traffic."

▼

Home Study Course in Reinforced Concrete Design

A practical course, newly revised, to aid in imparting an essential knowledge of reinforced concrete design, is announced by the Extension Division of the University of Wisconsin, Madison, Wis. Prepared for home study, this course in "Principles of Reinforced Concrete" aims especially to meet the needs of men who either want a first acquaintance with the subject or who want to bring their present knowledge up to date. It is intended also for engineers who have studied the subject in college and who wish to review it now in the light of the newer regulations for reinforced concrete.

The course is under the direction of Prof. H. E. Pulver, of the department of civil and structural engineering. Students enrolling in it are expected to have a good working knowledge of algebra and trigonometry and of the essentials of structural theory.

Overdrive for Motor Trucks

By FRANK M. HOUSE

NOW that passenger car overdrives are receiving so much attention from the public, truck operators of an inquiring turn of mind are asking whether overdrive offers anything of value in truck operation. Unfortunately the answer is usually pre-conceived. The word overdrive betokens speed, and the natural impulse is to associate it with speed. Why not, since the word itself suggests the idea of speed? The truck operator knows that he can already exceed legal or safe speed even with a heavy load, so he turns a cold shoulder to the thought of any more speed.

Having driven a passenger car equipped with overdrive, he realizes that while it reduces engine speed, it reduces pulling power too, and knowing what lugging an engine will do to it, he concludes that overdrive hasn't much to offer. Perhaps he already has a truck with, say a five speed transmission, direct on fourth with overdrive on fifth. He has observed that this has much the same characteristics and used for about the same purpose as a passenger car overdrive, and this strengthens his conclusion that overdrive isn't much if any use in truck operation. Or, having that overdrive gear in his truck transmission, he may say, "I have overdrive already," thinking that he is already fully equipped with all that overdrive has to give.

While these usual misconceptions are wrong, they are quite natural. This is unfortunate, because certain kinds of overdrive really offer a marked advantage to the heavy duty truck operator.

Roughly speaking, there are three different kinds of overdrive: the passenger car types, the truck transmission type, and the auxiliary transmission type. The overdrives in passenger cars and in truck transmissions are characteristically alike. They are one gear; a gear of higher ratio than high or direct, and their principal, if not only, use, is to cut down engine revolutions while the vehicle maintains a high road speed. Being of a higher ratio than direct gear they have less pulling power than direct, hence they are not particularly useful when any pulling is involved. Their principal use is connected with speed.

The third type of overdrive, which is that produced by the overdrive gears in an auxiliary transmission mounted behind the truck transmission, has an entirely different mechanical action. Instead of being only one gear, it is four different gears. It transmits a higher ratio, or overdrive, to each of the four forward truck transmission gears. Accordingly, we have an overdrive first, overdrive second, overdrive third, and an overdrive high. The first three of these, overdrive first, second, and third are all of lower ratio than direct or high, hence they rank better in pulling power than high gear. We can forget that they are labeled overdrive gears and consider them for what they really are—and that is, three pulling gears, used just like any other gear in the transmission.

Their principal value lies in the fact that they split the spaces or steps between the regular first and second, second and third, and third and high gears in the truck transmission. To say it another way, they give us gears between high and third, third and second, and second and low. The advantage of this is quite obvious and will be readily apparent to the trucker who operates on a route fairly sprinkled with grades. Suppose the truck comes to a slight grade, or enters traffic or even encounters wind resistance so that it cannot continue to pull in high. Ordinarily it drops back to third, even though third is lower than necessary, with a considerable reduction in road speed and quite possibly a little engine racing on the part of the driver anxious to maintain as much road speed as possible. Suppose, however, instead of dropping back to third, he can drop back halfway—to overdrive third—a gear lower than high but higher than third. There is considerable to be said for this and its value is apparent.

To put the value into figures we can take the speed of a typical truck. In high, its normal highway speed is 46 miles per hour, in third it is only 27 miles per hour—a loss of 19 miles per hour. But with an auxiliary transmission it would have a halfway between speed of 35 miles per hour. In other words, it gains 8 miles per hour by using this type of overdrive gear. The figures for different trucks vary of course, but typical figures are about as follows: overdrive third is 8 miles an hour faster than third. Overdrive second 5 miles an hour faster than second, and overdrive first 3 miles faster than first. The operator on a scheduled run with perishable freight to deliver on time will appreciate what that means, especially if he has much grade on his route. And he need not be afraid of that destroyer of engines, "lugging." These three overdrive gears are all lower than his regular high gear, so if his engine does a good job of pulling in high it will certainly pull even better in these overdrive gears. Engine power has nothing to do with it, if we consider high gear is the basis of comparison.

The fourth overdrive gear, overdrive high, has the same characteristics as the passenger car and truck transmission overdrive. That is, it reduces engine speed while it maintains high road speed; or, it maintains engine speed while it increases road speed. Perhaps the best way to show this is by figures, so here are the figures typical of one make and model of truck:

Engine RPM in High	Truck Speed	Engine RPM Overdrive High
2420 RPM	35 MPH	1860 RPM
2760 "	40 "	2120 "
3110 "	45 "	2390 "

If we are making 45 miles an hour in high gear the engine is running 3110 RPM, so we shift to overdrive high; the truck still makes 45 miles an hour, but the engine is running only 2390 RPM. We begin to save engine revolutions at the rate of 43,700 per hour. Quite a sizeable saving, and we get a smoother, quieter running, and perhaps a cooler engine and of course, we save some gas and oil. Or, the other way, we can use this overdrive high gear is, instead of loafing along at 35 miles an hour and turning the engine 2420 RPM to do it, we can shift over into overdrive high and breeze along at 45 miles an hour and run the engine at the same speed as before we shifted. To be exact, we can cut it a little; we only have to run it at 2390 RPM. Of course, this gear, being higher than the regular high, is not so good for pulling with a heavy load, so it comes into play principally when the truck is going home empty or proceeding light loaded. No matter when or how used, it's a gas saver and it cuts down the wear on rings and pistons and has a good effect on the valves and the engine in general.

Aside from these matters of time saving and economy for the truck operators, there is another consideration which is particularly timely, and that is the matter of safety. One of our friends was talking with the Director of Safety for the Interstate Commerce Commission. Assuming no responsibility for the correctness of his opinion, and only quoting his words, he said that the Commission's investigations have revealed that the lack of speed of trucks on grades materially impedes other traffic and also contributes to accidents.

OBSERVATIONS BY THE WAY

By A. PUDDLE JUMPER

¶ There is proportionately more bituminous paving in Denver than in any city I've visited. It's mostly in good shape, too.

• •

¶ There is a freedom of action characteristic of this western open country around Denver that doesn't exist in the East. After all, the country was settled only about Civil War time. A lingering spirit of the Old West still pervades the atmosphere.

• •

¶ Colorado is getting a large mileage of good bituminous mat coats each year. It seems to me that this work could be done by contract cheaper than by state forces. The state forces are fairly well organized but contract work usually has greater push.

• •

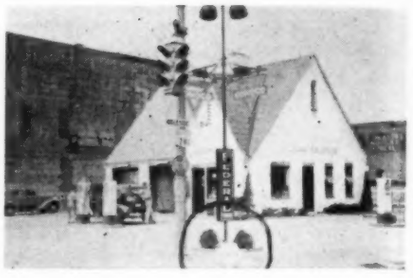
¶ In addition to the usual tests on fluid bituminous products, Colorado requires a low temeprature ductility test and the Oliensis spot test. They inspect the manufacture of road oils at the refinery, too.

• •

¶ Contractor on the Federal Aid highway up Floyd Hill between Denver and Idaho Springs erects new spring held curved plate guard rail. This rail is made in Denver.

• •

¶ There is no state law that requires the county commissioners to employ an engineer, and there is no association of county engineers in Texas. Only a few of the larger counties have what could be termed an engineer. In some of the counties the county surveyor does whatever necessary survey work is required in laying out new roads. Construction and maintenance is handled by the county commissioners, as a general rule, the construction being very limited. In these counties, major construction work is financed by bond issues and engineers are hired for the duration of construction work covered by the bond issue. It is also permissible, under the law, to create road improvement districts by two-thirds majority vote of land owners of that district. Engineers are usually hired to carry out bond issue construction work. Commissioners' court is responsible for all roads outside of the limits of incorporated towns or cities. There is no Governmental Unit such as township, in Texas. Road construction work is usually done by contract.



¶ Hastings, Nebr., has a good idea for street signing. The accompanying picture shows a sign on the corner of 2nd and Burlington Streets. Two signs are on each intersection of the town.

• •

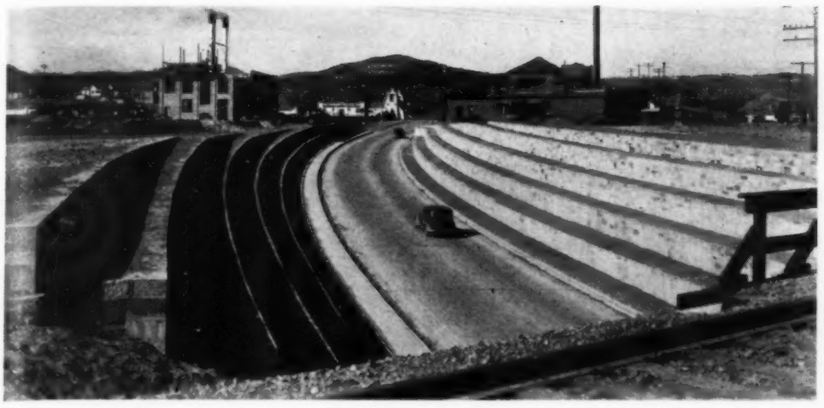
¶ On coming into Colorado, I was stopped at a Port of Entry. I asked Chief Engineer, Chas. D. Vail the why of the Courtesy Patrol, as they call it. He said it was to give motorists road information and to check gasoline bootlegging. Trucks are also stopped and required to pay a ton-mile tax, if foreign, on their load to their destination and return. They expect to increase the Courtesy Patrol shortly.

• •

¶ What an English engineer thinks: "Except for a few miles in the vicinity of towns and in the neighbourhood of beauty spots, etc., one often wonders where the pedestrians are for whom we have provided miles of footpath. The maintenance of these footpaths is a problem. Being so little used there is a tendency to try to construct them as cheaply as possible, with the consequence that the maintenance costs are relatively high. It will probably be found that a more expensive construction will pay in the long run. In some counties it is difficult to prevent them being used as horse riding tracks."—*F. C. Salmon, Area Surveyor, Leicestershire County Council. England. From Roads and Road Construction.*

• •

¶ Manchester Corporation Highways Committee reports that owing to complaints it has been decided to remove the iron pavement in Minshull Street, City (which was laid down as an experiment), and replace with granite cubes on a new concrete foundation.—*From Roads and Road Construction* [*England*]



¶ At Raton, N.Mex., I saw the above pictured terraced underpass. This is the first one of this type I've seen. Work was done by the W.P.A. The underpass was a New Mexico State Highway Department grade separation project. The stepped walls are colored granite blocks mortared together. It is quite pleasing in appearance.

• •

¶ Observed on Route 25 a sign near Port Huron, Mich.: "Roadside Table" and underneath a large spreading tree a nicely finished oak table with benches. The Michigan State Highway Department had a fine float in the Shriners' Parade at Detroit the other evening—one of the captions reading "Michigan Leads in Roadside Parks," which ties in with the above.

• •

¶ Several years ago when I was a member of the Grading Committee of the American Road Builders' Association, I commented in open meeting on the advisability of making borings on a grading job and plotting a grading classification profile. This is the first time I have known of the idea being used. I had nothing to do with this, however. Following is a letter regarding this engineering activity:

COLORADO ASSOCIATION OF HIGHWAY CONTRACTORS, INC.,
300 Flat Iron Building
Denver

June 7, 1937

Mr. C. D. Vail
State Highway Engineer
State Highway Department
Denver, Colorado
Dear Mr. Vail:

I am instructed by the Executive Committee of this Association to convey to you sincere appreciation.

These thanks are extended because of the parity of competition afforded contractors in examining, preparatory to bid, PWA 804 D, Project No. 351 D, between Strasburg and Anton on SH No. 102.

For years this Association has respectfully requested prestakement of projects. This project was an exception to this rule in that it was uniformly staked and presented to the contractors a complete vision of the work entailed.

In addition thereto, the new boring machine of the Department had been used to definitely determine, in every cut, the class of material which would be encountered.

In reviewing the bids on this project, you will undoubtedly be impressed with the high degree of competition which the prestaking of the project and testing of excavation made possible on the part of the contractors.

Members of the Association share the belief that the entire cost of the boring machine was earned by the Highway Department on this one project.

Very truly yours,
COLORADO ASSOCIATION OF HIGHWAY CONTRACTORS
By James B. Kenney,
Secretary-Treasurer

It has been estimated that this information for contractors who bid on the job saved the state of Colorado about $50,000.

• •

¶ W. M. "Bill" Williams, recently appointed Public Relations Director of the Colorado State Highway Department believes that pictures tell a story stronger than words. His job is to give the department human characteristics and personalize it with the people of the state. More power to you, Bill.

(Photo Courtesy U. S. Bureau of Public Roads)

DIRT ROADS

By Edwin Carlile Litsey

They hold a charm the concrete highways lack,
So homey-like, so leisurely they are;
Winding beside low hills, and looping back
To softly creep beside some pasture-bar.

Dirt roads were made for buggy wheels, and boys
To walk on barefoot, and for lines of geese,
The choiring meadow larks above them poise,
The cradling arms of twilight give them peace.

Their dusty beds are written like a scroll
Where Nature's children passed and left a sign;
With here and there a tiny water-hole
Where yellow butterflies drift down to dine.

Dusk comes to trail brown shadows through the air,
The humble wayside weeds grow moist with dew;
Couched in the road, his note a moaning prayer,
The whip-poor-will now sings the whole night through.

—*"The Filled Cup"* (The Standard Printing Company, Inc., Louisville, Kentucky)

ARIZONA IS TO HAVE A "MIRACLE MILE"—AN ALMOST PERFECT MILE-PIECE OF ROADWAY THAT WILL BE THE ONLY SAFETY-PLUS THOROUGHFARE IN THE WEST AND WILL PUT THE STATE IN THE NATIONAL HIGHWAY SPOTLIGHT.

ROAD BUILDERS'

JULY, 1937 **AMERICAN ROAD BUILDERS'**

CLEVELAND GETS 1938

Down the Road

By CHARLES M. UPHAM

Engineer-Director, American Road Builders' Association

The Demand for Great Bridges

What used to be a tedious all-day journey is now a pleasant hour's drive. The Golden Gate Bridge has been completed and opened to the public and San Francisco is now within easy reach of the great productive northern valley that extends from the other side of San Francisco Bay to the Oregon line. The opening of the Golden Gate Bridge is the second great bridge achievement of a great metropolis. Not so long ago the splendid Bay Bridge was thrown open to traffic between San Francisco and Oakland, giving speedy access to the other bay cities.

At the other end of the country, not many months past, a magnificent structure was projected across the waters of the mighty Mississippi, was completed in record time and was opened to the public of the South under the name of the Huey P. Long Bridge. Word now comes that the Louisiana Highway Commission opened bids on May 26 for a $7,000,000 bridge to span the Mississippi at Baton Rouge, the state capital. This bridge will be an unlimited aid for land transportation between the eastern and western sections of the southern United States, as well as to the central and eastern sections of the nation from Gulf ports. The bridge, to be of the cantilever type, will have five spans and will have a horizontal clearance of 848 ft. at the widest span and a vertical clearance of 65 ft. above maximum high water. It will be a tremendous undertaking, for the construction of a bridge across the Mississippi in Louisiana's flat terrain necessitates the construction of long and costly approaches. But so were the Golden Gate Bridge, the Bay Bridge and the Huey P. Long Bridge gigantic construction projects, unheard of and undreamed of by past generations.

Great bridges like these will continue to be built because of the ever increasing demand of transportation, a demand that has extended the highways of this great country of ours far out into the scarcely populated areas; the demand of a transportation that has brought our highways up to the banks of such bodies of water as the Golden Gate and the Mississippi River and has there registered a further demand that a way be provided to get across to the highways on the other side.

There is no one bridge within the borders of the United States that could ever have been built if man had not first had a desire to lay down a road that would take him away from his accustomed surroundings, that would broaden his horizon, that would eventually bring him to the banks of a mighty stream that would have to be crossed if he was to explore the regions on the other side. The desire to explore that is the heritage of the average American, his desire to pioneer, to open up new country, to build new towns and to spread civilization has been the one increasing purpose that has brought about the building of highways that have, in turn, brought our transportation facilities to the banks of great bodies of water and demanded a means of crossing to the other side to gain access to the country beyond.

We can thank the building of highways for the Golden Gate Bridge, for the great Bay Bridge, for the Huey P. Long Bridge and for the mighty span that is to be erected over the Mississippi at Baton Rouge, Louisiana.

D. C. Road Builders Organize Own Section

A District of Columbia Section of the American Road Builders' Association was recently organized at the Willard Hotel in Washington, D. C., at a meeting that was attended by more than 50 persons interested in highways and streets in the District.

The objective of the District of Columbia branch of the American Road Builders' Association will be to work for the continuation of the national highway program and to see to it that its part of that program is adequately carried out.

This organization meeting was the pep-filled preliminary to the event which was the feature of the Washington week of May 24, the annual May conclave of the American Road Builders' Association. The new section's constitution calls for a yearly session to directly precede the annual meeting of the parent organization and the group plans to have entertaining and instructive periodic gatherings, first of which is slated for a date some time in the near future. Charles M. Upham, Engineer-Director of the national association, presided and was assisted by William C. Slee, Assistant Engineer-Director, in the procedures attendant upon the organization of the new group. The officers elected to steer the course of the District of Columbia Section are Captain H. C. Whitehurst, District Highway Director and a former president of the national association, president; W. A. Gruman, vice-president; William A. Van Duzer, District Traffic Director and also a former president of the national association, second vice-president, and Francis J. Kelly, District Manager, Union Paving Co., secretary.

▼

Cleveland Gets 1938 Road Show-Convention

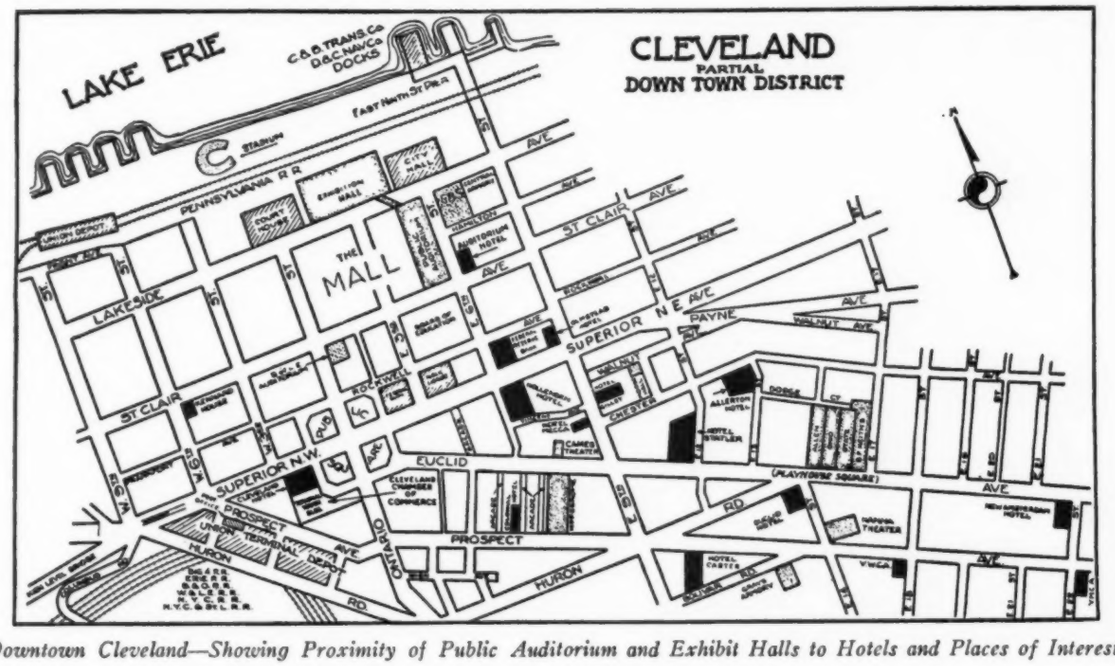
The "Barnum and Bailey" of the road-building world will be the powerful magnet that will draw more than 25,000 members of the highway industry and profession to Cleveland, Ohio, next January 17 through 21, for the 36th annual Road

REVIEW

DURING 1936 PERSONS NUMBERING 127 STAKED THEIR LIVES AND LOST IN A RECKLESS GAME OF CHANCE WITH DEATH AT CALIFORNIA RAILROAD CROSSINGS THAT SHOULD BE ELIMINATED BY PROPER SAFE-CROSSING CONSTRUCTION.

ASSOCIATION—WASHINGTON JULY, 1937

ROAD SHOW CONVENTION



Downtown Cleveland—Showing Proximity of Public Auditorium and Exhibit Halls to Hotels and Places of Interest.

Show and Convention of the American Road Builders' Association.

Announcement that Cleveland had been chosen as the location for the 1938 gathering of the A R B A clan was made in Washington, June 14, 1937, by Charles M. Upham, engineer-director of the association, after many deliberations by the organization's Joint Exhibit Committee and after final action by the association's board of directors on committee recommendations. This is the second time in three years that Cleveland has played host to the state, municipal and county officials; highway engineers and contractors, manufacturers, distributors, safety experts and enthusiasts, educators and numerous other interested individuals that make up the membership of the American Road Builders' Association.

Unprecedented interest is being shown by exhibitors whose requests for space reservations have already swamped the Washington offices of the American Road Builders' Association. These exhibits will range from lightweight accessories to the most massive of the heavyweight highway construction machinery.

Officials of the association are already busy with the planning of an all-inclusive program that promises to be the most comprehensive and most fascinating ever offered since these conventions first began making highway history 36 years ago.

Correspondence on hand in the executive offices of the association substantiates the prediction that the foreign contingent of delegates to the Cleveland Road Show and Convention will far outnumber any representation of the kind in the past. Central and South America, in particular, will be well represented at Cleveland.

The interest that has sprung up in the past few years in the Pan-American countries in the construction of highways knows no bounds. Every day now word comes of added accomplishments in the building of modern roads in those countries. Representatives from Central and South America, as well as the delegates from numerous other foreign nations, look to the A R B A Road Show each year for the newest developments in highway machinery and equipment and the latest contributions in construction methods. Distributors, likewise, from the 48 states consider the A R B A Road Show the "fashion show" of the highway industry. It is to the road-building world what the annual automobile show is to the automotive industry.

The public auditorium in Cleveland is one of the very few buildings in the country that is capable of housing the mammoth demonstration and tremendous space-consuming spectacle that will be the 1938 Road Show of the American Road Builders' Association. It is going to be, in every sense of the word, "the greatest show on earth" and the entire highway world will be on hand to see their own "Barnum and Bailey" in action.

Rawson-South Howell Double Overhead Crossing as Seen from the Railroad.

DIRT MOVING WITH TRACTOR-SCRAPER OUTFITS

In Constructing the Approaches to the Rawson—S. Howell Ave., Milwaukee, Wis., Double-Overhead

AN INTERESTING engineering project is the double-overhead crossing rapidly nearing completion at Rawson and S. Howell Ave., Milwaukee, Wisconsin. Considered the best from a safety and rapid travel standpoint it is also said to be only the second of its kind ever constructed, two roads crossing one another at the center of the overhead, directly above the Chicago North Shore and Milwaukee Electric car lines. Automatic traffic signals will protect motorists from accidents and will also speed up travel.

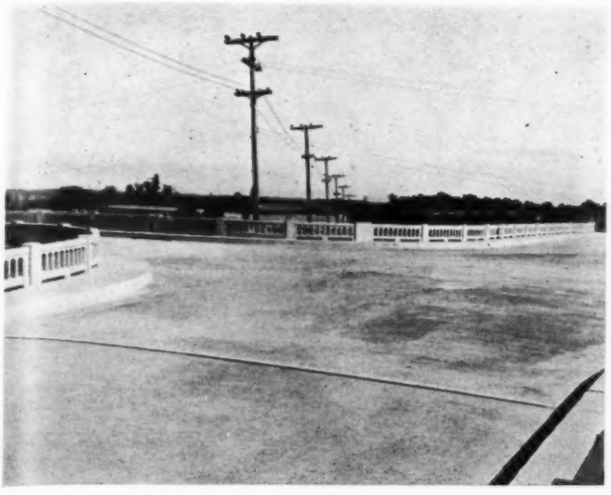
When completed, each of the four approaches will have a paved road surface of 30 ft., with a 5 ft. sidewalk on each side. Curb and gutter will drain the water from the bridge.

The Kramp Construction Co., Milwaukee, Wis., has finished making the fill for the approaches and is now placing the concrete pavement. The Worden-Allen Co., Milwaukee, Wis., constructed the bridge.

The project called for the moving of 276,500 cu. yd. of borrow—55,000 cu. yd. of this amount being taken from a subway excavation ½ mile from the bridge. There was also an item of 11,500 cu. yd. of common excavation. The bid for the approaches was $229,000.

The job was started in August, 1936, and work on it

Two Allis-Chalmers Model "L" Tractors Loading Continental Scrapers in the Borrow Pit.



Another View of the Double Overhead.

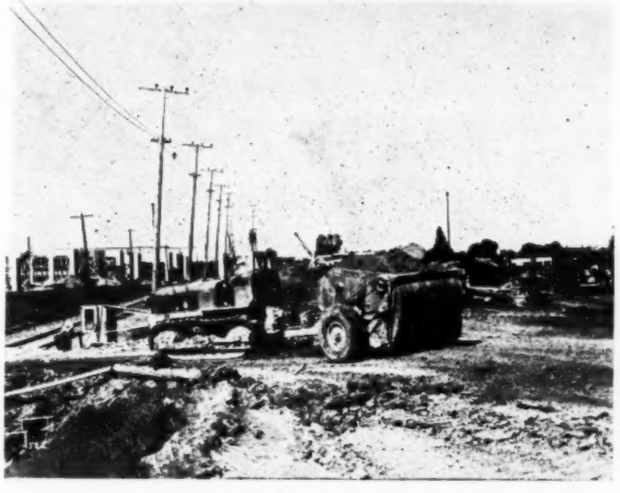
continued up to Jan. 29—frozen ground causing a temporary shut-down. Operations were resumed May 7. Unusually wet spring weather delayed trucking and shovel operations, but for the most part Kramp's tractors and scrapers kept moving dirt in spite of the soggy soil conditions. Some days as much as 4,000 cu. yd were moved. The project is expected to be completed by the latter part of August, well ahead of schedule.

A problem which caused the Kramp Construction Co. some concern was the necessity of hauling approximately 60 percent of the dirt across the Chicago North Shore & Milwaukee Electric Line tracks. On an average, four fast trains and extras passed at the overhead project every hour. However, a flagman was posted at the tracks and all the dirt was moved across without an accident occurring. Extra precaution also had to be exercised to guard against contacting the power transmission lines—33,000 volts passing through the wires. This was also accomplished without injury to anyone.

For the most part, the greater portion of the dirt over the 2,000 ft. average haul was moved by the tractors and scrapers. During the wet weather, they definitely established their superior performance abilities, often working in spite of slippery ground conditions. The Kramp Company's outfit on this job consisted of the following: Three Allis-Chalmers Model "L's" and three 7-yd. Continental scrapers; one Allis-Chalmers Model "L-O" controlled ignition oil tractor and 10 yd. Continental scraper; an Allis-Chalmers Model "WK" tractor and bulldozer; an RD8 and Le Tourneau scraper; a ¾ yd. Northwest shovel and from six to nine trucks.

The heaviest fill was made in the west approach to the bridge, involving the placing of 118,000 cu. yd. The west approach is also the longest, measuring 1200 ft. The shortest approach is the east entrance, being 600 ft. The north and south are 1,000 and 1,200 ft. respectively. Fills up to 30 ft. deep were made, with a 2 to 1 slope construction. The width across the top of the approaches is 60 ft.

Because of the sandy condition of the soil below the first 3 ft. of clay, it was found necessary to drive a large amount of piling. A culvert measuring 170 ft. by 18 ft. rests on 266 untreated pilings, 28 ft. lengths. The bridge columns are supported by 944 treated pilings, of 30 and 35 ft. lengths. The columns are from 3 by 3 feet up to 4 by 5 feet and are placed in bents—each bent having from three to four columns. The total piling measures 29,000 feet. Another interesting item is the large amount of structural steel used—over 1,000,000 lb. composed of girders 3½ ft. wide by 51 ft. in length. The cost of constructing the bridge was $192,000.



An Allis-Chalmers Model "L" and Continental Scraper About to Cross the Chicago North Shore Electric Car Line Tracks with a Load of Dirt for the South Approach. The Bridge Can Be Seen in the Background.

Backfilling over the Edge of the East Approach

A list of the major quantities for the overhead project follows:

APPROACHES

26,000	sq. yd. paving
33,300	sq. yd. concrete pavement reinforcement
1,100	sq. yd. special driveways
39,500	lb. bar steel reinforcement
2,650	lin. ft. underdrain
9,200	lin. ft. curb and gutter
46,000	sq. ft. concrete sidewalk
6,200	lin. ft. guard fence
15,000	sq. yd. seeding (to be increased)
5,000	sq. yd. sodding
2,100	mud jack sleeves

BRIDGE

2,800	cu. yd. excavation
3,240	cu. yd. concrete masonry
417,000	lb. reinforcing steel
1,154,000	lb. structural steel
48,000	lb. cast steel
4,000	lb. steel forging
1,900	lb. sheet lead
20,000	sq. ft. waterproofing

LOW COST OIL MIX SURFACING IN LIVINGSTON COUNTY, MICHIGAN

By WILLIAM J. SLAVIN
County Engineer, Howell, Mich.

OUR work in Livingston County has been mainly surface stabilization with the use of bituminous materials, such as slow curing asphaltic oil, medium curing cut-back asphalts, and tar mixed on the road with a densely graded, local, bank-run gravel. Thus far, we have built the surface on an ordinary gravel base without any special treatment to stabilize the base. We would prefer to build a bituminous surface on a well stabilized base, but our road funds are limited and our roads are carrying the traffic without excessive maintenance cost. To meet future conditions, there is the following possibility in connection with our slow curing oil surfacing. If and when traffic increases to the extent that the base is inadequate

Combining Salvaged and New Aggregate Into a Uniform Windrow

and maintenance cost becomes excessive, we can scarify the oil mat along with a suffiecient depth of the base and mix in enough new oil or other bituminous material to provide a stabilized base on which a new wearing surface can be laid. The roads we have surfaced carry traffic of about 300 to 800 vehicles per day. In 1935 we built three miles of oil-gravel road for the General Motors Proving Ground. These roads carry heavy traffic and are standing up very well.

The bituminous materials used are slow curing 70-80 per cent asphaltic oil meeting the Asphalt Institute specification SC-3, medium curing cut-back asphalt MC-2, and 28-35 viscosity tar. When using slow curing oil, we build the surfacing 3 in. thick loose measure, wheras with cut-back or tar, it is 2½ in. thick. We do not think it advisable to build too thin a surface on a gravel base.

Method of Construction

The existing gravel road is first bladed to true up the surface and remove corrugations. The loose material is scraped into a windrow in the center of the road. The number of cubic feet of aggregate required per linear foot of road is computed and enough new gravel is added to the windrow of salvaged material to make the correct total. This is done by metering the material through an adjustable proportioning device designed by the writer, which straddles the window of salvaged material. The opening in the rear of the proportioner is adjusted to correspond with the cross-sectional area of the bituminous surfacing under construction. Each truck is hitched to the proportioner and pulls it forward as the load is being dumped and the new and old aggregates are combined into a uniform flat-topped windrow. This method assures a uniform quantity of aggregate on the road and makes the control of the per cent of bituminous material in the mix an easy matter.

Aggregate

We produce our own aggregate from local pits with portable screening and loading equipment. A bucket type loader, equipped with a 2 ft. by 6 ft. single deck vibratory screen, used in conjunction with a drag line, makes an efficient outfit for this work. The use of densely graded aggregate is very necessary in this type of road surfacing and we take particular pains to get a material that has a good gradation of the various sizes of gravel and sand from one inch down to the finest sand. Most commercial gravel companies can produce a satisfactory material.

There is usually a deficiency of 100 and 200-mesh material in the gravel and we provide this by adding from 5 to 7 per cent of the finest bank sand obtainable locally. This material is usually added to the windrow of gravel on the road and, as it fills in the voids in the coarser material when mixed, the total volume of aggregate is not changed. If suitable filler material cannot be found locally, it must be shipped in, as this is a very necessary part of the aggregate. Limestone dust makes a suitable filler.

Aggregate meeting the following specification for grading is considered satisfactory:

	Per Cent
Passing 1-inch screen	100

Applying Hot Bituminous Material—160° F.

TRUCKS DO LOCOMOTIVES' WORK TIRES REPLACE STEEL RAILS

Read this True Tale of Tall Timbers

BY LOWELL THOMAS
NEWS COMMENTATOR

"Hauling out the logs in the northwest timberlands has always been a job for locomotives. Special track had to be built through the mountains. Logs came out on rails.

"They tried trucking. Tires broke down under the terrific loads. Others were cut and slashed to pieces by debris and undergrowth. Trucks mired in soft soil.

"Then Goodrich announced the Triple Protected Silvertown Tire. And truck logging, they tell me, became profitable. Now trucks haul tremendous log loads right out of the forest to the mill.

"Here's what Louis Joseph of Montesano, Washington, said in a recent interview: 'We have to take the roads as they come and frequently they are none too good. The loads are heavy and unbalanced. Yet with Goodrich Silvertowns I have never experienced a delay due to tire failure. Mileage is more than satisfactory.'

"There's a statement from a man who knows logging—and trucking—a hauling combination that means tire-killing service from the word 'go'."

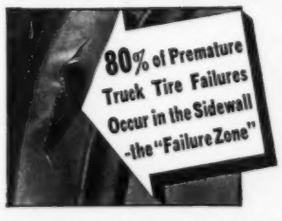
Lowell Thomas has traveled all through the logging country. He could talk to you for hours about the makeshift roads, the steep climbs, the seemingly impossible tire jobs.

Do you know that you can get for your trucks the same tire that is making good on hundreds of logging operations? And you don't have to pay a premium price for it, either!

Here is why this tire, the Goodrich Silvertown, stands up where others fail. A new invention, Triple Protection, is built into the sidewall. This 3-way development actually checks 80% of premature failures! It makes the sidewall as strong as the tread. It protects against blowouts. It makes the tires run cooler.

Now you can get extra mileage, extra service at no extra cost. These tires cost more to build—but Goodrich adds no premium on the selling price.

See a Goodrich dealer for prices on your sizes—or write The B. F. Goodrich Company, Akron, Ohio



HOW TRIPLE PROTECTION WORKS

1 PLYFLEX—distributes stresses throughout the tire—prevents ply separation—checks local weakness.

2 PLY-LOCK—protects the tire from breaks caused by short plies tearing loose above the bead.

3 100% FULL-FLOATING CORD—eliminates cross cords from *all* plies—reduces heat in the tire 12%.

Goodrich *Triple Protected* Silvertowns

SPECIFY THESE NEW SILVERTOWN TIRES FOR TRUCKS AND BUSES

Passing ¼-inch screen	60- 80
Passing 10-mesh sieve	40- 60
Passing 40-mesh sieve	20- 40
Passing 100-mesh sieve	8- 10
Passing 200 mesh sieve	5- 8

Bituminous Material

The moisture content of the aggregate should be reduced as much as possible before the application of the bituminous material. This is done by spreading out the windrow of gravel and discing it for a day or so, to permit evaporation. The bituminous material is applied with a pressure distributor at the rate of ½ gal. per square yard for each application. We prefer to use a ½ gal. per application instead of a greater amount, because there is a better opportunity to compensate for errors by making allowance in subsequent applications. When using slow curing asphaltic oil as a binder, we use 0.52 gal. per square yard per inch depth of aggregate or 1.56 gal. for a 3-in. depth, which is about 5 per cent by weight. We have found by experience that this is the correct amount to use with our aggregate. It makes a surface that will not ravel, and yet the mat has enough stability so that it will not corrugate. We heat the bituminous material to about 165° before applying same.

The following formula for computing the correct percentage of oil for various gradations of aggregate has been quite extensively used, and we occasionally use it as a check on our work:

P=0.02A plus 0.045B plus 0.18C

Where A=percentage of aggregate retained on No. 10 sieve

B=percentage of aggregate passing No. 10 sieve and retained on No. 200 sieve

C=percentage of aggregate passing No. 200 sieve

Particular care should be taken to get the correct amount of oil in the mix and uniformly distributed, because fat or lean spots are almost certain to cause trouble. When using medium curing cut-back or tar instead of slow-curing oil in the mix, we use 0.6 gal. per square yard per inch of aggregate.

Mixing

Each application of oil is mixed into the aggregate by a three section disc drawn by a small track-type tractor which follows closely behind the distributor. Various types of mixing equipment are available, including multiple blade mixers and traveling plants, which are being widely used. We are using power graders on our work

Disc Follows the Distributor Mixing in the Bituminous Material While It Is Still Hot

Mixing Is Continued and Completed by Power Graders

and they are satisfactory, although slower than the other types of equipment. The more rapid the mixing operation, the more necessary it is to have the aggregate dry in the beginning. Wet weather, of course, delays the work and increases the cost of mixing.

When the bituminous material has all been applied and disced in, the aggregate is put into a windrow and bladed back and forth across the road until thoroughly mixed. It is important that mixing be continued until the whole mass is uniform in consistency and black in color. Exposure to the air and sunlight has a beneficial effect on the mix, in addition to drying out the moisture, and money spent on further mixing after the aggregate is all well coated, is not wasted. We do not prime the base when using slow curing oil. Unless the prime material penetrates thoroughly into the base, there is a chance that part of it be absorbed upward into the mat, causing a fat mix.

After the mixing operation is finished, a thickened edge is provided for by making a triangular cut with the grade blade reversed to throw the excavated base material outward. This cut is about 2 in. deep at the outer edge and feathers out about 2 ft. in from the edge. The mixture is then spread out with the graders. We find that we get a much straighter edge by carrying a little excess material to the edge of the channel and leaving it in a small windrow to be pulled in when the spreading is nearly finished. The road is then opened to traffic and bladed lightly for two or three days while traffic partially compacts the surface, after which it is rolled with a seven-ton tandem roller. When cut-back or tar is used in the mix, the rolling is done immediately after spreading, or on the following day.

For a seal, we use a light application, consisting of ¼ gal. emulsion or cut-back, covered with about 15 lbs. of 0.10 in. to 0.25 in. birdseye gravel or chips. We prefer a light seal on the slow-curing oil surface, because it will be easier to break up if we should want to scarify and remix the whole mat in later years. Thus far, less than one-half of our roads have been sealed.

Costs

Our construction cost for slow-curing oil-mix surfacing 20 ft. wide and 2½ in. compacted depth averages, without a seal coat, about $1,800 per mile, or about 15c per square yard. This includes labor, equipment rental and materials, with slow-curing oil costing about 5¼c per gallon and gravel 15c per cubic yard in the bank. The cost of screening, loading and hauling gravel is

OVERDRIVE FOR MOTOR TRUCKS

What good is Overdrive? Is it useful in a dump truck? A truck proceeding up a grade? A truck in city traffic? A logging truck? A coal delivery truck? In *any* truck?

At first glance "No!" But those who use it in heavy duty service emphatically say *"Yes!"* Let's find the reason.

There are several kinds of Overdrive. Overdrives in passenger cars and overdrive gears in truck transmissions reduce engine speed at high road speed. These Overdrives are just *one* gear, with *one* use. They are used for speed. They are not useful for pulling.

But Overdrive in an auxiliary transmission mounted behind a truck transmission is *not* one gear. It is *four* gears! It is a *different* Overdrive! It is used for *pulling*! It has *many* uses!

23% FEWER R.P.M.'S

Watson-Brown-Lipe gives an overdrive to *each* transmission gear—to first, second, third and high. It reduces engine speed at high road speed and produces three transmission power gears — *pulling* gears.

What value lies in that? Time saving. Performance. Miles per hour profit. How so? Consider. If on slight grades or traffic a truck cannot use high, it must drop back to third. Third may be too slow, may race the engine. But drop to Overdrive third, which is lower than high and higher than third. Is that a benefit? Here is the answer: in High, its speed is 46 miles per hour; in Overdrive 3rd, 35 miles per hour; in Third, 27 miles per hour.

Overdrive third is 8 miles per hour faster than third. Overdrive second, 5 miles faster than second. Overdrive first, three miles faster than first. And *these* overdrives *pull*. They save time! Time is money!

20% LESS FUEL

These overdrive gears do not lug the engine because they are *lower* than high. If an engine will pull *at all* in high, it will pull in these three gears. Engine power has nothing to do with it!

So those are wrong who say: "Fast enough now. Don't need Overdrive. Engine hasn't enough power for Overdrive. Overdrive lugs engines." This thought comes from associating Overdrive only with speed. But Watson-Brown-Lipe Overdrive produces *three* gears for power plus *one* primarily for speed; the Overdrive high. This gear slows the engine or it speeds the truck.

These figures show the benefit of Overdrive high: All figures typical.

Engine RPM in High	*Truck Speed*	*Engine RPM Overdrive High*
2420 rpm	35 mph	1860 rpm
2760 rpm	40 mph	2120 rpm
3110 rpm	45 mph	2390 rpm

At 45 miles per hour, Overdrive high reduces engine speed from 3110 to 2390 and saves 43,700 revs. per hour. Or, instead of going 35 miles per hour at 2420, go 45 at 2390. Overdrive high saves fuel, saves engine wear, when light loaded or returning empty.

Boiled down, this is the value of Watson-Brown-Lipe Overdrive for motor trucks! It has power for pulling. It is a time saver. It is a performance creator. It is a profit maker. Be guided by an understanding of it and proceed to profit with it.

* * * *

Watson-Brown-Lipe Auxiliary Transmissions combine Overdrive *with* Underdrive — producing 12 speeds forward and 3 reverse — a maximum of *usefulness*.

AUXILIARY *Transmissions* **WATSON-BROWN-LIPE** H.S. WATSON CO., SAN FRANCISCO & TOLEDO

Surface Texture—Not Sealed

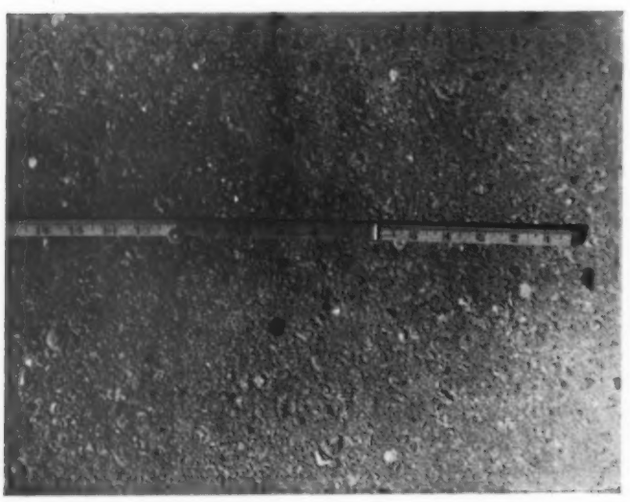
about 50 to 60c per cubic yard for a 4-mile average haul. The cost of the surface, using cut-back asphalt or tar, is correspondingly higher, depending on the cost of the bituminous material.

Maintenance

The major part of the maintenance work consists of patching spots that fail, due to frost boils or weak places in the base. These are usually excavated to a depth of 6 or 8 in. and filled in with oil-gravel mix. In case of bad frost heaves, we excavate the silty material to a depth of about 2 ft. and back-fill with gravel before making the surface patch. During construction operations, we pick up about 30 cu. yd. of oil-gravel mix from each mile of road before it is spread, and put it into stock piles. This usually supplies enough patching mixture for several years. The annual cost of patching averages less than $30 per mile for roads that have been built from one to six years.

In general, we prefer the slow-curing oil to the other bituminous materials. The mat is much more flexible and better able to withstand the frost heaves without breaking up in the spring. Another reason is that most any of the low cost bituminous surfaces become more or less out of shape, due to heaving, settling and patching after a period of years, and there is a definite satisfaction in the knowledge that a surface can be scarified and remixed at nominal cost and made as good as new. The medium curing cut-back and tar mixes have some advantage, in that they are damaged less by tractor lugs, and the like, and when laid on a firm, well-drained base, have been entirely satisfactory. We have built cut-back asphalt type of surface principally in the residence section of towns and villages in our county.

The construction of this low-cost type of surface should have just as careful supervision as would be given in the building of a higher type of road. The base should be as thoroughly drained as is possible and pockets of silt, if present, should be removed by excavating and back-filling with good material. The gradation of the aggregate, particularly that of the fraction which passes the ten-mesh sieve, is very important, because the stability and bitumen capacity of the aggregate itself is mainly dependent on the gradation and quantity of this finer material. Lack of sufficient fines and use of too much bitumen are almost certain to cause trouble later on. Careful proportioning of the aggregate and bitumen, so as to have the correct per cent of the latter in the mix, is very necessary. It is better to have the mix a trifle lean than too rich, especially where the roadbed is not too well drained, as the absorption of the moisture from the base may cause the surface to corrugate if the maximum amount of bitumen is used. This type of surfacing has been very satisfactory in our county and our experience has proved that the saving in maintenance cost, as compared with gravel road maintenance, is sufficient to pay for the cost of the surfacing in five years or less.



The Finished Surface

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A Courteous Official Notice

No one likes to be told what to do or reminded of delinquencies, and there is a growing body of public officials who, recognizing this very human trait, word their communications accordingly when possible. Such a course gets results with less effort and vastly less irritation than a rougher one, and helps promote a good community spirit.

Rough methods can still be used if necessary on citizens who do not understand courtesy.

The following card, sent to all householders in the village, is an example of a statement at once friendly, courteous and adequately strong:

VILLAGE OF WINNETKA
TRIMMING OF SHRUBBERY

"There are a considerable number of cases in the Village where shrubbery and trees on private property have grown to such an extent as to overhang the public sidewalk, interfering with pedestrian traffic. This is a violation of the Municipal Code, which requires that trees and shrubbery be so maintained as to not extend over or upon any public sidewalk or street.

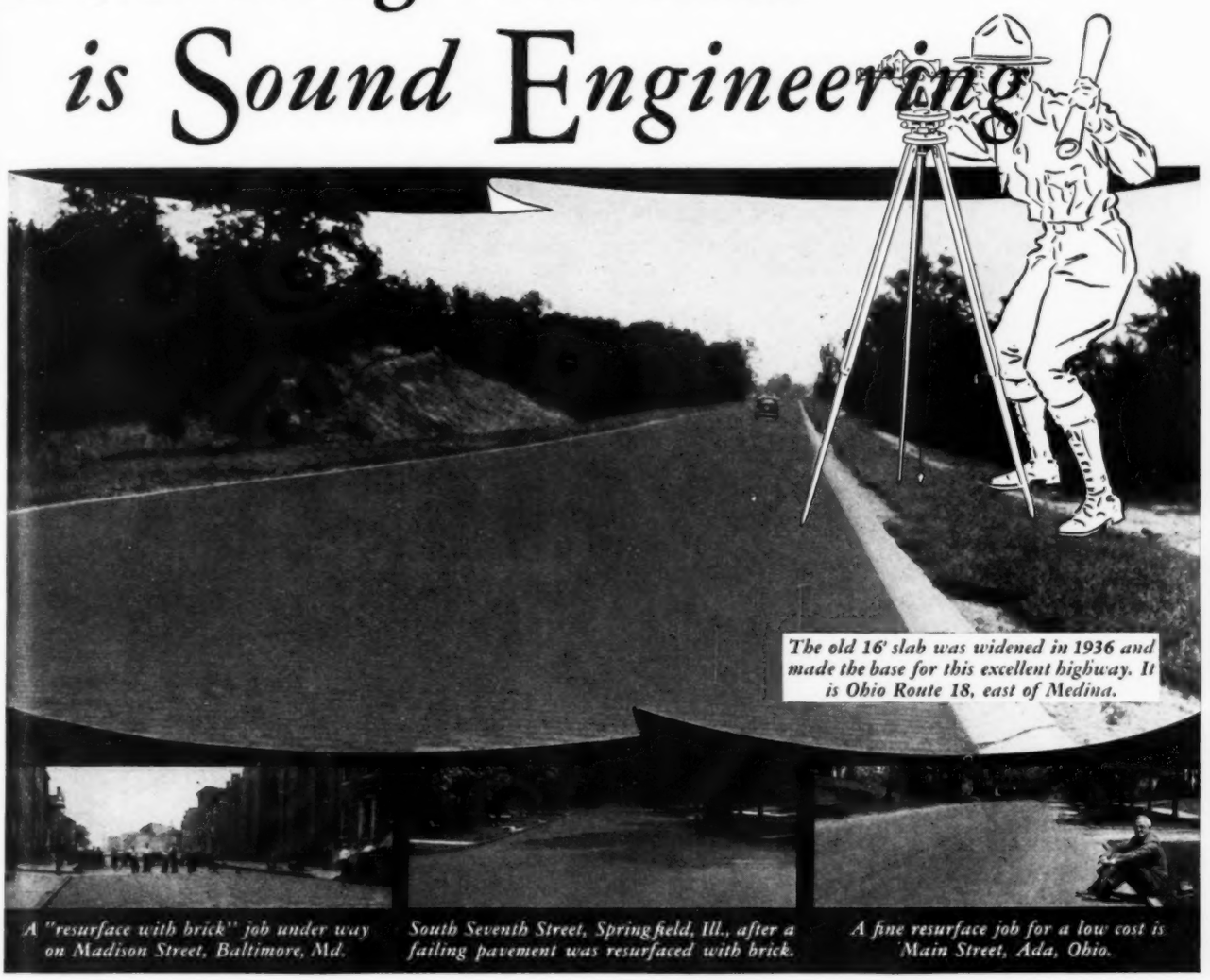
"No doubt in most cases the conditions exist because of unfamiliarity with Village regulations, or at least because of unintentional negligence. The co-operation of all persons to whom this notice applies is respectfully requested to the end that shrubbery and trees encroaching on sidewalks be trimmed within ten days from date, and be kept properly trimmed during the growing season.

"In addition, it is requested that all shrubbery at street intersections, where the view of motorists may be obstructed, be trimmed to a height of four (4) feet for a distance of at least fifteen (15) feet back from the corner. Winnetka has a low traffic accident rate. Your help in maintaining this record will be appreciated.

Yours very truly,
THE VILLAGE OF WINNETKA,
By H. L. Woolhiser,
Village Manager."

June 4, 1937.

Resurfacing with Brick *is Sound Engineering*



The old 16' slab was widened in 1936 and made the base for this excellent highway. It is Ohio Route 18, east of Medina.

A "resurface with brick" job under way on Madison Street, Baltimore, Md.

South Seventh Street, Springfield, Ill., after a failing pavement was resurfaced with brick.

A fine resurface job for a low cost is Main Street, Ada, Ohio.

● The sound practice of using worn pavements as the base for new pavements dates back to ancient times. Roman road engineers kept building the new over the old until the succeeding layers were piled high—it gave us the word "highway."

Today, highway engineers are turning failure into success by brick resurfacing all manner of pavements that have become a handicap to traffic and a burden to the public purse.

This done, the community owns a new and modern trafficway at a normal cost and is relieved of future excessive upkeep.

Resurfacing with brick is sound engineering. The settled subgrade is left undisturbed; the old pavement structure has high salvage value as a base. The job is quickly completed with a minimum of interruption to traffic.

Once resurfaced with brick a pavement can withstand the destructive action of *weather* as well as traffic. Thirty years or more of service is not uncommon. For additional information, write National Paving Brick Association, (Affiliated with Structural Clay Products, Inc.) National Press Building, Washington, D. C.

BRICK

FOR NEW AND RESURFACE JOBS

AERIAL PHOTOGRAPHY PART OF COLORADO ENGINEERING

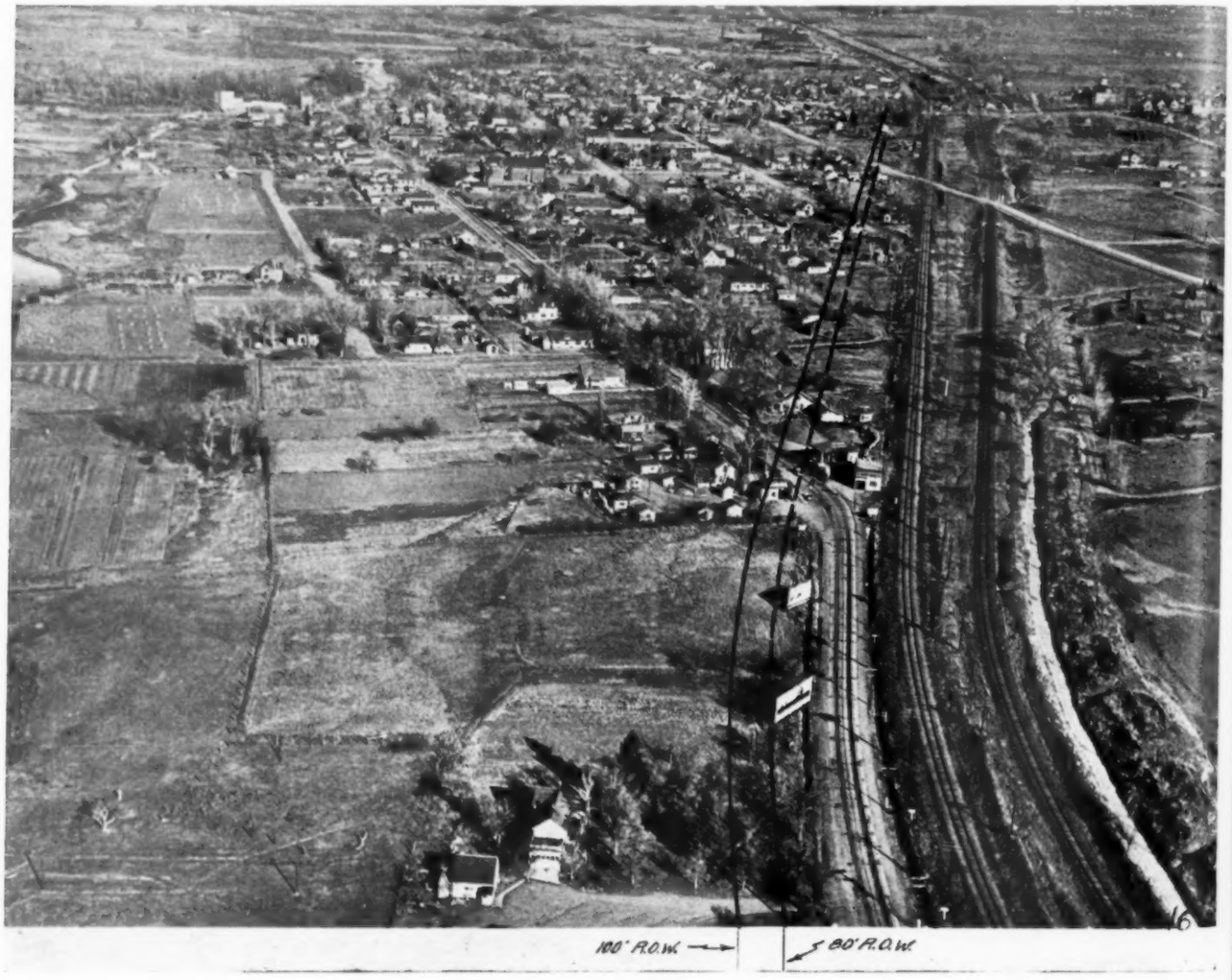
By J. G. ORWIG

Reconnaissance Pilot

FOR the past several months the Colorado State Highway Department has been experimenting with the use of oblique aerial photographs in connection with highway location and construction. The results have been satisfactory from several viewpoints. Oblique photographs in this open rough country afford the locating engineer a chance to study a great deal more country than can be seen by standing on the ground. He has a visual perception of the relationships of various locations which supplements the mental picture he obtains. Final location is not expected from this method but for reconnaissance purposes they are a valuable time saver.

Another advantage of the aerial oblique photograph is their use in discussing locations and right-of-way lines with delegations of citizens. The ordinary man can read and understand a picture where a blueprint will immediately scare him. By plotting centerlines and right-of-way lines, on oblique photographs the engineer can show a property owner just where the line is expected to go; just how drainage will be handled; and just how fields will appear after the new road is built.

Study of an oblique photograph saves time measuring up property proposed for acquirement. Such was the case of the proposed change through Littleton, Colorado, on the Denver-Colorado Springs Highway, U. S. No. 85. As shown on the accompanying picture, the proposed route, parallel to the railroad track was photographed and right-of-way lines drawn on the photograph. Study of



Right-of-Way Lines for 80 and 100 Feet from Center Line of Present Road Shows Buildings to Be Moved and Property to Be Acquired at Littleton, Colo., Had Widening Project Been Adopted.

Welded WIRE REINFORCEMENT does a REAL job

The positive way in which welded wire reinforcement controls incipient cracks in concrete pavements, the ease with which it is handled in the work and the economy it effects in maintenance costs are resulting in the inclusion of this superior type of reinforcement as a standard specification in many road building programs.

Pittsburgh Welded Wire Reinforcing prevents progressive cracking because of its many closely spaced members electrically welded at the mill into an accurate and uniform fabric. It comes to the job ready for use, and already "built up," and goes into the slab with a minimum of labor.

Complete information concerning the use of Pittsburgh Welded Wire Reinforcing in modern highway construction will be sent to you upon request. Use the coupon below or write to the

PITTSBURGH STEEL CO. • GRANT BUILDING • PITTSBURGH, PA.

Pittsburgh NATIONAL Reinforcing

PITTSBURGH STEEL COMPANY
1643 Grant Bldg., Pittsburgh, Pa.

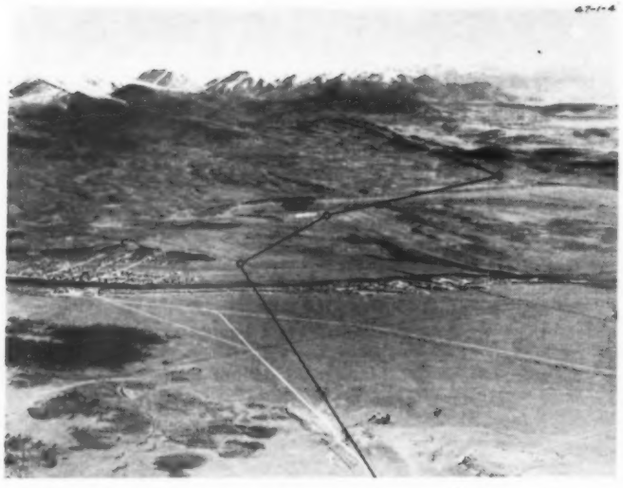
Gentlemen: I am interested in complete information on the use of Pittsburgh Reinforcing in road building.

Name .....

Title .....

Address .....

.....



"Fly Line" for Reconnaissance near Fairplay, Colo. Proposed Road Heads Toward Pass in Upper Right-Hand Corner of Picture.

the series of pictures indicated the excessive cost of acquiring new right-of-way. The photographs clearly established that this proposed route encroached upon too many valuable properties besides producing a dangerous situation where the main street of the town crossed the proposed route and the railroad tracks. A new location back of the town was selected.

Another picture near Fairplay, Colorado, shown herewith, indicates how reconnaissance of new location is aided by aerial oblique photography. The line plotted on the picture is called a "Fly Line." White crosses are placed on the ground at certain control points before the photograph is made. These are then circled and a straight line drawn between them. The location engineer can then study this in connection with his first-hand knowledge of the lay of the ground and from it decide upon the most economic location. The line shown in the picture is for a proposed relocation headed for Kenosha Pass about 15 miles away in the upper right-hand corner of the picture. These "Fly Lines" are not measured accurately but estimated from map distances in determining lengths of tangent lines.

Later, when the preliminary survey is run, the line is photographed again. Right-of-way lines are plotted on the pictures and these are used by the engineers for purchase of new right-of-way. The method nas been found to be quite advantageous in this rough country.

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English Road Testing Machines

THE Road Research Board of the Department of Scientific and Industrial Research, 16 Old Queen St., Westminster, S.W. 1, London, England, has just issued its second annual report. In it are described several types of road testing machines used in the Road Research Laboratory. Three of these machines are used for accelerating road conditions to determine relative life of different types of bituminous construction. Road Machine No. 1 represents the smallest machine with which a full sized pneumatic tire can be used for the tests. The track is some 5 ft. 6 ins. in diameter, and the machine is novel in that the "road" itself is revolved under the wheel whose axis is stationary. In No. 2 machine the track diameter is 38 ft. and the test road can be laid under normal road conditions. The test with this machine is carried out with full sized tires under their rated loads. Road Machine No. 3 is the largest and approximates nearest to actual road conditions. With it a full sized truck is employed running at its maximum speed and the road is again laid under normal conditions. The mean diameter of the track is 110 ft. and the truck is driven round this electrically, being attached to a central post by a heavy steel girder. The use of Road Machine No. 1, which is the remotest from actual road conditions, in conjunction with laboratory tests, eliminates certain undesirable factors in road construction and narrow down the field of suitable mixtures for surfacings or indicate desirable alterations in the methods of surface dressings. As a result of this work tests on selected surfacings or thin surfacings are carried out in Road Machine No. 2, and after this further weeding out full scale trials are made with Road Machine No. 3. With this machine investigations are being carried out on recent types of thin surfacing coats in which the premixed materials are laid to a thickness of ¾ in. to 1 in.

For the study of skidding a standard machine, consisting of a motor-cycle and sidecar combination, has been developed by which records of the measure of friction between the tire of the sidecar and the road can be made under practical conditions up to a speed of 30 miles an hour. Experiments with the machine have given values which agree with the normal experience of road users. A theoretical study has been undertaken to explain the various effects which have been found but only a partial proof has as yet been supplied. Before the causes of skidding, the report states, can be eliminated these must be definitely established, and further work to this end is proceeding at the Road Research Laboratory. The report points out that the limitations of the present apparatus are as follows:—one size of tire and load, both of which are smaller than those used on cars or commercial vehicles; tires with smooth treads, a necessary feature in order to obtain comparative results, as it has been found that the values obtained vary with the form of tread employed, whilst those with smooth tires can be repeated; the values obtained were for sideway slipping, although some results for skidding in the direction of travel have shown that these are in agreement with sideway force coefficients when smooth treads are used.

In order to overcome these difficulties another apparatus has been designed which will be towed by a two-ton truck and will allow tests to be made on tires varying from 26 in. to 27 in. with loads up to 600 lb. Another important piece of apparatus which has been designed and constructed at the Laboratory will enable accurate measurements of surface irregularities on roads to be made. This apparatus employs a 16-wheeled carriage consisting of four 4-wheeled bogeys all of different track widths. The recording apparatus carried on this 16-wheeled carriage gives a profile of the road surface independently of any reference points or fixed rails on the side of the road. The machine also carries an instrument for registering the sum of the heights of surface irregularities over any length of road and enables the number of surface irregularities of heights from 0.2 in. upwards to be automatically recorded.

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FIVE YEAR ROAD PLAN IN SOUTH AFRICA—The first year's work on the Union of South Africa's program of highway improvement, begun in April 1936, did not quite reach the scheduled 1,000 miles. However, satisfactory progress was made and it is now contemplated to complete the 2,000 miles by April 1938. The National Roads Board's plan proposes the construction of 5,396 miles of main roads by March 1941.

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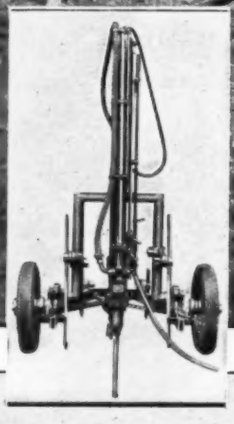

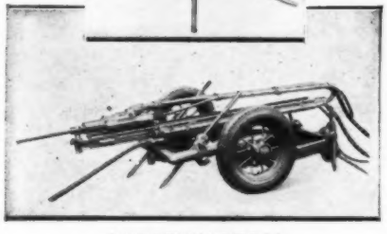

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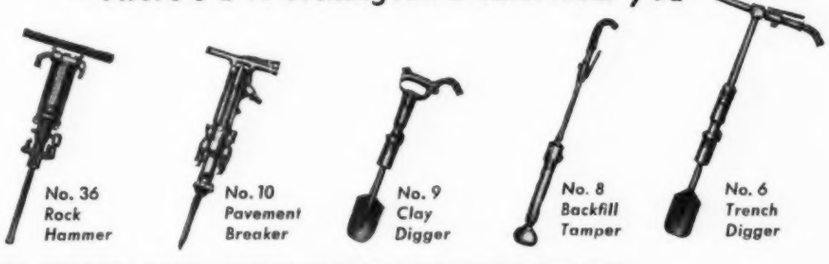

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MODERNIZING RAILROAD GRADE CROSSING PROTECTION

By GEORGE W. BARTON
Traffic Engineer
Chicago Motor Club
Chicago, Ill.

IN DEALING with railroad grade crossing accidents, it is the popular thing to characterize the American motorist by "Lunatic," "Try-to-beat-it-fool," or "Maniac" and to lay the blame for this type of accident directly in his lap. As proof of the suicidal intent of American motorists, the fact was cited that 39 per cent of the grade crossing accidents occur when a motorist runs into the side of a train, instead of the train hitting the motorist.

I believe that most traffic engineers in their dealings with the motoring public have come to find that the average motorist is not a fool intent on killing himself as expeditiously as possible, but rather a normal human being who appreciates positive and informative control and regulation and who very successfully keeps out of trouble at a location or at a time when the hazard is made obvious to him. We are all familiar with the fact that many apparently dangerous locations are free from accidents because the hazard is obvious to the motorist. Therefore, may there not be some other explanation of the grade crossing accidents other than the irresponsibility of the man in the automobile?

In 1936 there were 1,786 persons killed, 4,930 injured in 4,277 grade crossing accidents. It is true that compared with the total traffic toll in the United States, grade crossing accidents are relatively minor. Yet, if understood engineering methods, readily applied, can effect the saving of 700 or 1,000 lives a year, it is certainly worthy of serious study.

Crossing Problem Becomes More Serious

In spite of recent highway-railway grade separation construction and installation of grade crossing signals, grade crossing fatalities are increasing rather than decreasing. And this is not surprising. In recent years, we have seen the introduction of high speed trains with train operations on more frequent schedules. Though we in highway transportation may have been inclined to feel that railways were a somewhat out-moded means of transportation, the railways are staging a decided comeback.

Rail freight traffic is following the normal trend of business. Passenger travel, however, had been falling steadily in the face of the best business conditions this country has ever known until three years ago when a marked upturn started:

Year	R. R. Freight Traffic—Billions of Ton Miles	R. R. Passenger Traffic—Billions of Passenger Mi.
1920	410	47
1929	447	31
1932	234	...
1933	249	16.3
1934	269	18
1935	282	18.5
1936	339	22.4

Therefore with the improvements in rail transportation and the reduction in rates, the frequency of exposure at railway crossings is increasing.

Then too, we are not making much headway in eliminating highway and railway crossings at grade. Almost as fast as these crossings are eliminated, either through separation or relocation, new crossings are opened up by new construction. The building of highway-railway grade separations certainly is not the answer. It has been estimated that the cost of constructing separations at all existing grade crossings would be approximately the same as the original cost of construction of all the railroads in this country. It seems apparent, therefore, that the grade separation can be used only at those crossings where the delay is so great that the cost of grade separation construction is justified on an economic basis.

Nature of Crossing Accidents

What then are we going to do with the remaining grade crossings where the problem is one of accidents rather than one of delay? The character of the problem is somewhat indicated by the table of accidents according to the type of protection, manner of collision, and light conditions. Accurate comparisons are not possible owing to the lack of data on volumes of rail and highway traffic.

RAILROAD-MOTOR VEHICLE ACCIDENTS—UNITED STATES, 1935

Type of Protection	Number of Cross'gs	Total Accid'ts	Struck by Train Day	Struck by Train Night	Ran into Train Day	Ran into Train Night
Gates	4,314	44	1	20	2	21
Watchmen	5,528	315	55	105	26	129
Visible and Audible Signals	10,330	287	124	57	37	69
Audible Signals	3,450	135	67	35	8	25
Visible Signals	6,578	412	203	82	48	79
Unprotected (Including fixed signs)	204,031	2321	979	414	227	701
Total	234,231	3514	1429	713	348	1024

Motorists Running Into Side of Trains

It is true that in 39 per cent of the 1935 accidents, the motor vehicle ran into the side of the train. But is this significant? With the train and automobile each traveling 60 miles an hour, a small fraction of a second difference in timing of either the train or the motor vehicle might have resulted in the train hitting the car instead of the car hitting the train. However, it is interesting in this connection to note that 75 per cent of these accidents in which the car struck the train occurred after dark. I imagine most of us have had the experience of our hair standing on end when driving along a rural highway as our headlights picked up the freight train across our path with the engine somewhere out of sight

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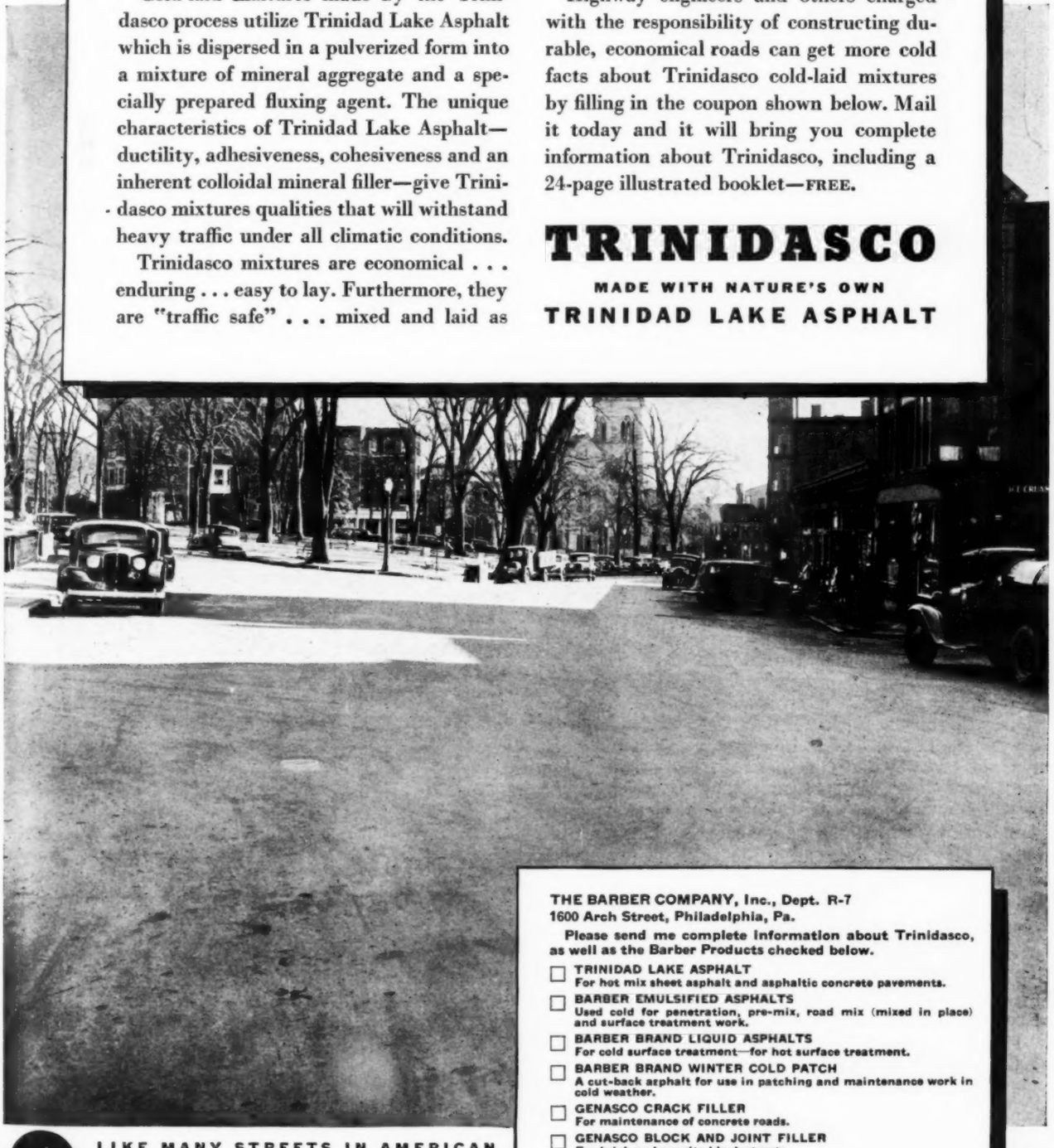

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and no other illumination anywhere around to show us this barricade across the highway. Frequently, we are made aware of this freight train's presence only by the flash of the headlights of oncoming cars between the wheels of the passing train. Certainly this situation could be greatly improved, preferably by the actual illumination of the crossing, or at least by the installation of adequate reflectors on the sides of all freight cars. They are now required on the sides of long trucks so why should they not also be placed upon the freight cars.

The railroad man points that one of every twelve grade crossing accidents occur when a motorist runs into the side of a train that is standing still. Here again it may be largely a matter of illumination. Of the 264 accidents of this type in 1935, 20 occurred in the day time and 244 at night.

Why Motorists Ignore Present Signals

In some circles, there is a widespread conviction that the "fool" motorist insists on ignoring crossing signals, running through crossing gates and in general endeavoring to kill himself in spite of all the warnings erected for his protection. I can readily sympathize with the feelings of the motorist even if his actions cannot be condoned. Certainly the old railroad stop sign is out of date—it seems too much to expect that hundreds or thousands of motorists will approach a crossing where ten or fifteen trains pass daily and come to a complete stop before proceeding across the tracks. As far as the cross-bucks and advance warning signs are concerned, they are another example of the old story in which the boy cried, "Wolf."

The wig-wags bear out the old saying that "you can fool some of the people, some of the time . . ." When a motorist approaches a railroad crossing and sees the wig-wag or flasher light in operation about all it means to him today is that "This is a railroad track and on it somewhere there is a train." With the track circuits controlling this warning being operated to provide a 20-second warning for the fastest train, it might mean that in 20 seconds a streamliner is going to roar over this crossing or in a minute and a quarter a freight train is going to loaf by. It may mean that there is a switch train somewhere in the track circuit that will never cross the highway. It may mean that a car has been left temporarily on the track. It may mean that a train has stopped several hundred feet away at a station and won't cross the highway for some time. If two or three slow trains, one after another, come into the track circuit from the same or opposite directions, the signals may be kept working with little or no necessity, for minutes. The average motorist has been fooled so many times by signals operating in this manner that he cannot be blamed for coming to believe that grade crossing signals merely mean that there is a train somewhere on the tracks and that he therefore might as well proceed. Of course it may happen that the switch train he observes is hiding the approach of a fast express or perhaps a fast express is coming from the other direction.

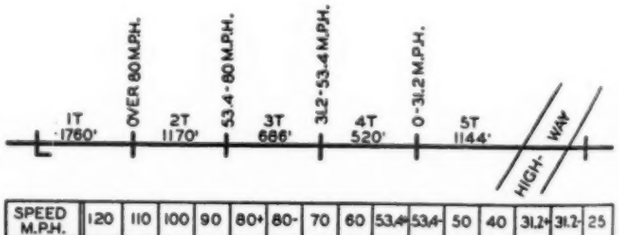
The parallel problem in street traffic control is well understood. It has long been known that if traffic signals are operated when there is no cross traffic to justify them, motorists will not stop and wait. Conversely, when this unreasonable traffic control is supplanted by reasonable control such as traffic actuated signals, the motorists will appreciate it and cooperate through greatly improved obedience.

Certainly it is not very difficult to understand why many motorists prefer to take a chance on running into a crossing gate rather than stop and wait. In a study recently made of the gate operation in a busy shopping district, we found a number of cases where the gate was closed for three minutes and in one instance where it was closed for four minutes and 55 seconds while trains dragged in from opposite directions or stopped at a nearby station. With delays of this extent possible, it is not surprising that motorists, seeing the gates start down, will do their best to squeeze by at the last minute.

Operating Crossing Signals Reasonably

I believe that we would find the attitude of the average motorist towards grade crossing devices greatly changed were these devices made reasonable and positive in their operation. Incidentally, by positive operation I do not mean a procedure in which a motorist has his car wrecked or is killed by the protective device if he does not obey it. I have already cited the parallel to fixed time and traffic signals at lightly traveled intersections compared with traffic actuation. Why can't some similar treatment be applied to the railroad grade crossings? The answer is that it can and has been done. For example, the Skokie Valley Line through Niles Center, just north of Chicago, carries both high speed North Shore trains and the slow elevated trains which make stops at a number of stations along the route. At Main Street, the track circuit operating the automatic gates on the south approach contains a time element which lowers the gates at one time if the approaching train is a fast North Shore or lowers it much later if it happens to be a slow moving elevated. On the Southern Pacific at Palo Alto, Calif., a very serious crossing problem involving both accidents and delays was practically solved by the installation of a time control in the track circuit which operated the gates at one time if the approaching train exceeds 35 miles an hour in speed and at another time if the train is going less than 35 miles an hour.

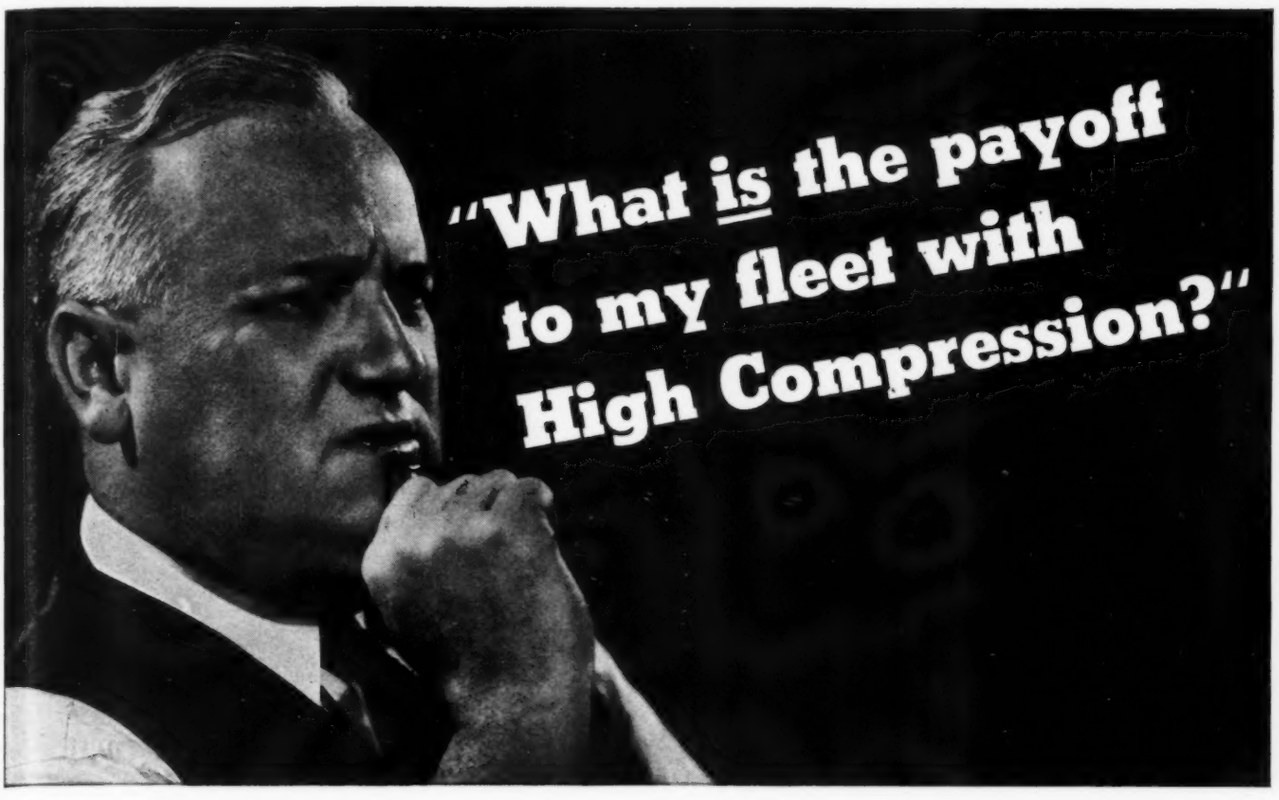
Over a year ago an article appeared in the magazine "Railway Signaling" describing uniform time control for grade crossing signals. Under this system there is one time-element relay by which the speed of the approaching train is measured over a section of track circuit of a definitely computed length. If the train is



SPEED M.P.H.	120	110	100	90	80+	80-	70	60	53.4+	53.4-	50	40	31.2+	31.2-	25
WARNING TIME-SEC.	20	21.8	24	26.7	30	20	22.8	26.6	30	20	21.4	26.7	36	25	31.3

Diagram Showing Flexibility of Control Possible by Using Same Single Time Element Relay with Different Lengths of Track Circuits

going faster than the computed speed, it enters the second track circuit before the relay has closed its contacts and the crossing signals start operating at once. If the train is going so slowly that the time-element relay has already closed its contacts before the train reaches



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3. Earlier models can be high compressioned when they are overhauled by installing high compression pistons or heads.

4. All high compression engines burning gasoline give their maximum performance on gasoline of high anti-knock value, with the spark set to match the quality of the fuel, according to manufacturer's specifications.

If you have further questions on fuels and their part in increasing the efficiency and performance of *your* trucks or buses, write Department B. Ethyl Gasoline Corporation, Chrysler Building, New York, N. Y., manufacturer of anti-knock fluids for premium and regular gasolines.

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the second circuit, the crossing devices will not go into operation until the train reaches the third circuit.

Using this same single time element relay but with a number of different lengths of track circuits, great flexibility of control is possible as may be seen from the diagram.

With this circuit, trains can stop within any one of the sections of the track circuit, except the last next to the crossing, without operating the signals. Thereby the nuisance of signal operations is avoided while the train stops at a station or switches. Without going any farther into the details of such a system it is enough to say that it is possible to introduce an effective time element in grade crossing signal circuits and that such a thing has already been done.

Other changed conceptions of control at grade crossings must be adopted. That it is not unreasonable to expect the train crew to assume some of the responsibility at the grade crossing is indicated by the action in Wilmette, Ill. In this suburban town, it had been customary for the gates along the North Shore tracks to be closed for unreasonable lengths of time, tying up traffic in the heart of the business district, while the train stopped at the station. This was changed by installing a push button for operating the gates and a signal for the engineer which is green when the gates are down and red when they are open. The gates are now closed by the trainmen themselves after the train has stopped at the station, discharged or taken on passengers, and is ready to proceed. Certainly also it is reasonable to give the motorist the right-of-way at some of the minor grade crossings. Wouldn't it be better than at present to remove the standard cross-bucks from a number of industrial sidings and place the responsibility entirely on the railroad to make sure that the highway is clear before trains attempt to cross?

Educating the Motorist

Assume that all of our grade crossing protection is changed over night to operate in proportion to the speed of the approaching train, with no unnecessary operations for switching trains and the like. Now we must devise some way to tell the motorist that the old system is changed and that when these crossing devices are in operation, it actually means that a train is going to arrive at that crossing with 20 seconds or less time. We must convince these motorists that there is no longer any premium on endeavoring to beat the grade crossing signals but instead a very positive hazard. I believe that as crossings are changed over to the timed control, the wig-wag or flashing light must be replaced by an actual barrier, namely, an adequate crossing gate. By no means do I mean the old flimsy, poorly painted type of gate which is illuminated by a dingy kerosene lantern. Instead I refer to a modern gate which carries adequate flashing warning lights and probably also a form of flood light to illuminate the gate itself. Then to overcome the high maintenance costs when motorists occasionally strike these gates, I would use a modern gate which can be struck without damage either to the gate or to the automobile. I have witnessed demonstrations with new gates which have been struck by trucks traveling at 45 miles an hour without breaking any of the glass on the truck or without damaging the gate, which swung out of the way and then returned to its normal position. This modern gate would also be of the type which would not be damaged or made inoperative if it should strike the top of a car on its downward movement.

Expenditures and Their Effect

You may well ask how much this suggested grade crossing protection is going to cost. As nearly as I can discover, each speed control circuit costs approximately $200 on each approach on each track. The gates themselves would cost between $1,200 and $3,000 depending upon the number and size of gates used. Therefore, the total cost of such an installation should be between $4,000 and $15,000 depending upon the number of tracks and complications in the layout.

These proposed expenditures for improved grade crossing protection do not constitute merely another additional cost for the railroad or for the motoring public but rather are an investment which will pay returns. Certainly if the proposal has any value, fewer grade crossing accidents with their loss of life and costly damage suits should result. These accidents are costing the railroads between $35 and $200 for each mile of track in their systems. This type of control should make it possible for the railroad to eliminate grade crossing watchmen. It should result in less damage to grade crossing equipment. Finally, it should meet the demands which are now being made for more expensive type of treatment such as grade separations. Certainly, it would be far more sound economically, rather than concentrating expenditures at one hazardous grade crossing, to use this same amount of money in providing adequate protection at ten to twenty.

Rail and Highway Transportation Both Concerned

The railroads have already begun to adopt the newer practices in grade crossing signalling. In addition to the improvements mentioned at Palo Alto, Niles Center, and Wilmette, the railroads are considering two other major innovations. A few unlighted crossings have been illuminated with sodium vapor lights and switches have been installed to enable train crews to cut out the crossing signals when the train is merely switching, stopping at a water tank, etc. The railroads most certainly are concerned with the accident problem at grade crossings. Their accident problem is no longer one of passengers because passenger deaths are now ranging from about thirty a year to none at all, while at the same time the railroads are killing approximately 1,700 people at grade crossings. The motor public as a whole has a decided interest at stake. The motorist is not only interested in saving his own life but also in conserving time by doing away with needless delay. To gain these two ends, the motorist must, I believe, be willing to contribute his fair share of the cost of modernizing grade crossing protection. The foregoing is a paper presented May 13 at the Midwest Meeting of the Institute of Traffic Engineers.

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NEW HIGHWAY TUNNEL PROPOSED FOR SWITZERLAND—The Government of Switzerland has approved a project to construct a tunnel through Grassen (Mountain) near Titlis. The tunnel is to be 3.7 miles long, 27.8 ft. wide and with connecting roads will cost about $3,000,000.

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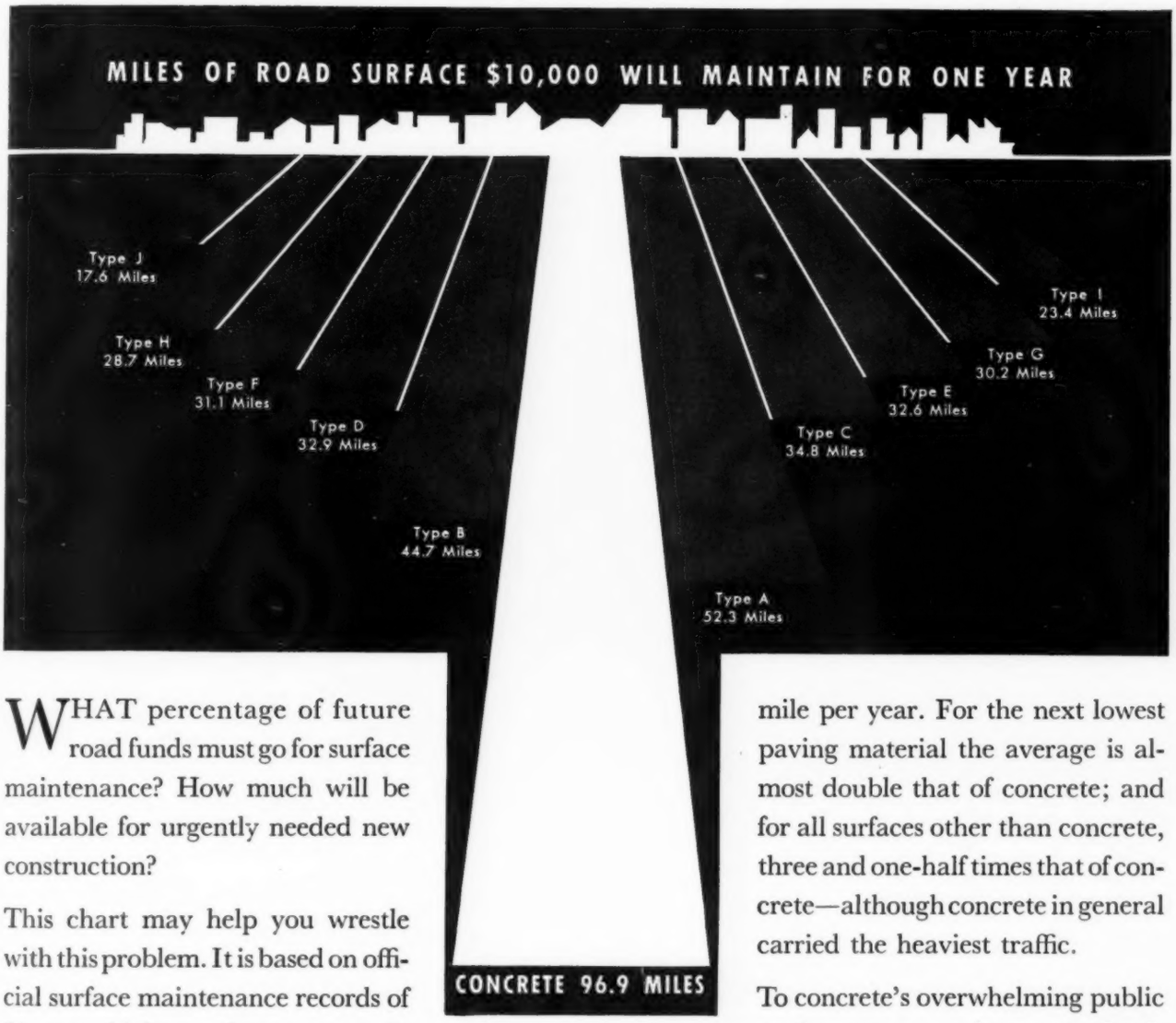
U.S. BUREAU PUBLIC ROADS' COURSE IN SOIL STUDY—A scheduled course in the study of soils is now being given to highway engineers in the public service by the U.S. Bureau of Public Roads. The first one began June 15 in the research laboratory of the bureau at Arlington, Virginia. Many engineers already have received instruction in methods developed in the laboratory.

How much for Maintenance?



WHAT percentage of future road funds must go for surface maintenance? How much will be available for urgently needed new construction?

This chart may help you wrestle with this problem. It is based on official surface maintenance records of 21 state highway departments. It represents the most complete study of its kind ever made. No selection or exclusion of data. Covers maintenance periods ranging from 2 to 16 consecutive years and averaging 9—135,000 miles of state-highways, or nearly half the surface mileage of state trunk systems, under all conditions of traffic, subgrade and climate.

The answer is clear, conclusive! Surface maintenance costs for concrete average $103.17 per mile per year. For the next lowest paving material the average is almost double that of concrete; and for all surfaces other than concrete, three and one-half times that of concrete—although concrete in general carried the heaviest traffic.

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THE $50,000,000 PENNSYLVANIA TOLL HIGHWAY

IN 1837, the State of Pennsylvania, at that time subsidizing construction of railroads and canals, sent out surveyors to lay out the route for a new railroad from Chambersburg, in the Cumberland Valley, to Pittsburgh, 125 miles to the West. In the party was John Augustus Roebling, engineering apprentice, destined later to construct famous suspension bridges at Cincinnati and Niagara and to be father of the man who built Brooklyn Bridge.

A second survey was made by the State in 1844, and ten years later private interests resurveyed the route and obtained a charter for the "Duncannon, Landisburg & Broad Top Railroad." This venture was successively known during the next quarter century as "Sherman's Valley & Broad Top," "Pennsylvania & Pacific," "Harrisburg & Western," and finally "Southern Pennsylvania Railroad." Although more than $300,000 had been spent the railroad lived only on paper, an idea awaiting concrete expression.

Mr. Vanderbilt Steps In

Suddenly the phantom road of many names became a real weapon in a dramatic struggle between those rival transportation giants, Morgan and Vanderbilt. In 1881, when railroads were expanding lustily and without restraint, Vanderbilt's New York Central declared war on Morgan's Pennsylvania line. Cause of the war was Pennsylvania's purchase of the West Shore Line, which threatened New York Central's monopoly of the Hudson Valley. Vanderbilt retaliated by building 164 miles of double track grade through the mountains between Harrisburg and Pittsburgh, striking into the very heart of the Pennsylvania's domain.

This belligerent gesture cost Vanderbilt $10,000,000. He first sent in 300 engineers, who made a topographical survey covering 1000 square miles and ran 5000 miles of location lines. This work took two years to finish and is considered the most complete railroad survey in American history.

Thousands of laborers followed the engineers, and villages to house them mushroomed into being all along the 208-mile route. Tunnels pierced the hills. Bridge piers of limestone thrust up from the rivers. And crude forerunners of the modern steam shovel muzzled into their banks.

By November, 1885, the railroad was nearly 60 percent completed. Four and a half miles of tunnels had been driven, more than 5,000,000 cu. yd. of grading accomplished.

And then Vanderbilt and Morgan signed a truce. Each agreed to get out of the other's territory. New York Central absorbed the West Shore Line, and Pennsylvania inherited "Vanderbilt's Folly."

The end came with the suddenness of a turned-out light. Construction officials were summarily dismissed. Workers laid down their tools at night, never to pick them up again. The roadbed and tunnels which had cost $10,000,000 and 27 lives to build were abandoned to the elements. The Southern Pennsylvania Railroad was dead, and for 50 years weeds grew undisturbed over its grave.

How the Toll Road Idea Started

The idea of resurrecting the old railway in the form of a modern motor road was conceived by the Pennsylvania State Planning Board in 1934, at a time when the Federal Government was searching with considerable concern to find useful work for America's unemployed.

It was a bold plan, but strong arguments backed it. Completion of the South Penn's nine ancient tunnels would give motorcar operators greater safety and protection from mountain storms and fog than existing roads could afford. The old roadbed's easy grades would be ideal for heavy commercial trucks. It meant the saving of several hours in running time between Philadelphia and Pittsburgh.

There was even a military argument. In the event of war such a modern, heavy-duty, military road would become a defense asset, facilitating the movement of munitions and equipment from Pittsburgh, where they are produced to the Atlantic coast. The cost of this highway would be $50,000,000, about the same as the first cost of a battleship. And the road could be expected to pay for its construction and upkeep by tolls.

Convinced by these arguments, the Pennsylvania legislature authorized the state highway department to cooperate with the Works Progress Administration in surveying the right-of-way and conducting a general engineering investigation.

Surveys and Investigations Started

The project got under way in January, 1936. The old route was divided into 10-mile sections, and half-a-dozen surveyors were assigned to each. Laborers started draining the tunnels and clearing debris from the grades. This activity continued for 13 months, and Federal funds for this project, practically all of which went for labor, amounted to $59,598. The sponsor's contribution was $48,660. In May of the present year a supplemental project was approved to complete the survey and preliminary work. It provided $45,700 additional in Federal funds and $51,000 from the Pennsylvania Highway Department. Between 40 and 70 men have been on the job for the past year and a half, and the preliminary survey is now practically complete.

All reports indicate that those workmen of 50 years ago did their job well. The tunnel masonry is sound and the arches are well preserved; drainage culverts, embankments and grades are still strong and dependable. Their value to the highway is estimated at several million dollars.

The survey further reveals that the old roadbed will help to provide the following desirable features:

1. A maximum grade of 3 percent, and a maximum curvature of 6 degrees with a radius of 995 feet.
2. By-passes around all cities and larger towns.
3. Elimination of four railroad and 26 highway grade-crossings, with safety ramps for feeder roads.
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State Turnpike Commission Created

Encouraged by these favorable reports, Pennsylvania's legislature passed an act, signed May 21, 1937, creating the Pennsylvania Turnpike Commission to build and operate a $50,000,000 4-lane toll highway over this route, from a point on Route 11, 15 miles west of Harrisburg, across the Cumberland Valley and through the Alleghenies to a point on the Lincoln Highway 20 miles east of Pittsburgh, or from Middlesex in Cumberland County to Irwin in Westmoreland.

The commission is authorized to float turnpike revenue bonds to finance construction. These bonds will not be a debt against the state; they will obligate only the moneys collected in tolls.

It is estimated that the minimum daily traffic will be 5000 vehicles, assuring an annual income of some $5,000,000. The authorizing act provides that when the road is paid for and the bonds retired, it shall become part of, and be maintained by, the state's highway department, free of tolls.

Some Details of Proposed Highway

More than seven miles of the route's 164¼ will be through tunnels—37,389 lineal feet, to be exact. These tunnels run through solid rock, and are from 26 to 28 feet wide. They will be ventilated where necessary. Road tolls will be collected at their entrances.

The road's elevation ranges from 400 feet above sea level, near Harrisburg, to 2400 feet at the Laurel Hill tunnel. Cars crossing Pennsylvania's southern mountains over present routes must climb an accumlated vertical height of 13,880 feet, up 9 percent grades. On the new road they will have to climb only 3,900 feet.

There will be four traffic lanes—two double-lane separate roadways, each 22 feet wide, or more. And cars moving in opposite directions will be separated by a 6-foot parkway.

▼

Social Security Act and Highway Contractors

DELINQUENT road contractors and builders employing one or more persons have been advised by Commissioner of Internal Revenue Guy T. Helvering to make immediate tax returns as required under the provisions of Titles VIII and IX of the Social Security Act to avoid further payment of drastic penalties which are now accruing.

Commissioner Helvering pointed out that every person employed by road contractors and builders came under the provisions of Title VIII which imposes an income tax on the wages of every taxable individual and an excise tax on the pay roll of every employer of one or more. This tax is payable monthly at the office of the Collector of Internal Revenue. The present rate for employer and employee alike is 1 per cent of the taxable wages paid and received.

Under Title IX of the Act, employers of eight or more persons must pay an excise tax on their annual pay roll. This tax went into effect on Jan. 1, 1936, and tax payments were due from the employers, and the employers alone, at the office of the Collector of Internal Revenue on the first of this year. This tax is payable annually, although the employer may elect to pay it in regular quarterly installments.

The employer is held responsible for the collection of his employee's tax under Title VIII, and is required to collect it when the wages are paid the employee, whether it be weekly or semi-monthly. Once the employer makes the 1 per cent deduction from the employee's pay, he becomes the custodian of Federal funds and must account for them to the Bureau of Internal Revenue.

This is done when the employer makes out Treasury form SS-1, which, accompanied by the employee-employer tax, is filed during the month directly following the month in which the taxes were collected. All tax payments must be made at the office of the Collector of Internal Revenue in the district in which the employer's place of business is located.

Penalties for delinquencies are levied against the employer, not the employee, and range from 5 per cent to 25 per cent of the tax due, depending on the period of delinquency. Criminal action may be taken against those who willfully refuse to pay their taxes.

The employers of one or more are also required to file Treasury forms SS-2 and SS-2a. Both are informational forms and must be filed at Collectors' offices not later than next July 31, covering the first six months of the year. After that they are to be filed at regular quarterly intervals. Form SS-2 will show all the taxable wages paid to all employees and SS-2a the taxable wages paid each employee.

Participation in a state unemployment compensation fund, approved by the Social Security Board, does not exempt employers from the excise tax under Title IX. Nor does the fact that there is no state unemployment compensation fund relieve the employer of his Federal tax payments. In those states where an unemployment compensation fund has been approved, deductions up to 90 per cent of the Federal tax are allowed the employer who has already paid his state tax. These deductions are not allowed unless the state tax has been paid.

This tax is due in full from all employers in states having no approved fund. The rate for 1936 was 1 per cent of the total annual pay roll containing eight or more employees, and for 1937 it is 2 per cent. The rate increases to 3 per cent in 1938 when it reaches its maximum. The annual returns are made on Treasury form 940.

An employer who employs eight or more persons on each of twenty calendar days during a calendar year, each day being in a different calendar week, is liable to the tax. The same persons do not have to be employed during that period, nor do the hours of employment have to be the same.

Important Features of Taxing Provisions of Social Security Act

Actual money, when paid as wages, is not the sole basis on which the tax is levied. Goods, clothing, lodging, if a part of compensation for services, are wages and a fair and reasonable value must be arrived at and become subject to the tax.

Commissions on sales, bonuses and premiums on insurance are wages and taxable.

Officers of corporations whether or not receiving compensation are considered employees for the purpose of taxation.

Wages paid during sick leave or vacation, or at dismissal are taxable.

Traveling expenses required by salesmen are not wages if the salesmen account for, by receipts or otherwise, their reasonable expenditures. That part for which no accounting is made is construed as a wage and is taxable.

Exercise great care in filling out Treasury forms SS-1 and 940. Directions are easy to follow and correct returns mean no unnecessary delay.

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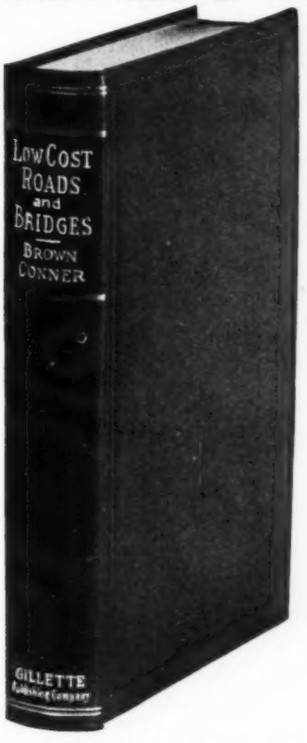

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by

V. J. Brown, C. E.
Publishing Director, Roads and Streets, Asso. Mem. Am. Soc. C. E., Mem. Western Soc. Eng., Mem. Am. Road Bldrs. Assn.

C. N. Conner, B. S. in C. E.,
Chairman, Department of Design, Highway Research Board. Formerly Engineering Executive, Am. Road Builders Assoc. Mem. Am. Soc. C. E.

544 Pages
Fully Illustrated—$6.00

Congress made this book particularly useful. How? The passage of the Hayden-Cartwright Act authorized $25,000,000 for farm-to-market road work for each fiscal year 1937-38 and 1938-39. The act requires the money to be matched, thereby making $50,00,000 available for each of those two years. This book is a technical treatise on low cost road and bridge design and construction and covers just the type of work expected to be done on the farm-to-market roads.

In ten well-arranged chapters the authors have covered the fundamentals of highway design, economics and planning, grading, surface treatment, low-cost paving materials and their testing, inspection and maintenance. An additional chapter discusses highway bridges. Although the book is not overloaded with illustrations, there are enough to make clear the text.

In a work of this kind, one would not expect to find any discussion of the more expensive types of surfacing —sheet asphalt, brick, stone block, etc.—nor does it appear. The treatment of the lower types, however, is entirely adequate. The authors have not hesitated to enlist the cooperation of a number of specialists, which adds much to the value of their book.

The text is so written that it can be used as a field book for actual construction. Step by step processes are described. Of particular value are the discussions on tar and asphalt and the interpretation of tests of these bituminous materials. The manufacture of bitumens for road work is explained. Other useful information is the section which explains what the various trade named and patented product materials are and their distinguishing characteristics.

Engineering of low cost construction and economics of highway types are thoroughly treated. In compiling the text matter Messrs. Brown and Conner state—"The authors' problem was one of selection, correlation and synthesis, rather than research, experiment and analysis." The book belongs on the desk of every engineer and contractor doing road work.

All the types of low cost surfacing processes are discussed and denfiite "best practice" methods are explained in detail. When considered in conjunction with the discussions on economics, the text indicates definitely what type of improvement is the most economical for a particular road. In fact, herein lies the greatest value of the book—helping the engineer or executive to decide what type of improvement would be the most economical under particular local conditions. The national traffic and highway planning survey will indicate that for economy, many state highways should be improved by some low-cost surface rather than a high type of construction. For this work this book will prove valuable far beyond its cost.

The authors of this volume were far-sighted enough to know that for future construction the economics of highway types would play an increasingly important part in improvement programs. They have, therefore, thoroughly discussed this phase of highway planning.

The book is highly recommended as a criterion of low-cost road construction practices and methods.

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R&S-7-37

Unified Highway Systems in France and Germany

By THOS. H. MacDONALD
Chief, U. S. Bureau of Public Roads

DURING a study of conditions abroad, there was opportunity to observe various aspects of the problem of governmental control and the inevitable effects growing out of them. Paris presents the opportunity to observe major projects under way for the relief of street and highway congestion in a metropolitan area. One gets a conception of the instability of great population centers when new transportation facilities are available. If we have accepted the changing aspects of our own cities because they are in a relative sense youthful, the example of Paris is illuminating since it is an old world city, ancient in comparison to any of our own. Paris did not grow without direction, although it cannot be said to have adhered to a single plan through the years. What we now see is the result of progressive conceptions, each developed in harmony with those preceding. The earlier undertakings of major importance, beginning with those fostered by Louis XIV, were the result of power exerted through a single individual. Highways, but particularly bridges, developed by Louis XIV and Napoleon are yet in service, a tribute to the ability of the technicians of a century and a half ago. Because of governmental control exerted through rulers who had the foresight and determination to accomplish improvements of magnificent proportions adequate far into the future, Paris has remained undated, a city without time.

With the advent of motor transportation and the inevitable changes which it has brought in the amount of traffic and the extension of the city's influence into the surrounding country, new major projects are now formulating; and although, in the course of years, France has supplanted its once absolute rulers by a form of democratic government not unlike our own, it is important to note that the modern projects are being conceived and directed by engineers of the National Department of Highways, all of whom have been trained in the Ecole des Ponts et Chaussees, the French School of Roads and Bridges. For it has been this same great technical institution that has supplied the genius to carry out all the great national engineering undertakings at least as far back as Louis XV, and it is this institution whose sons are now the agents of a sovereign people in carrying out the modern street and highway developments in and surrounding the city of Paris. With this long unbroken succession of single-minded, long-visioned control I ask you to compare the situation as to engineering control existing in the area comprising the Chicago Region.

Or take another example,—that of the Germany of today. Here a program of construction of superhighways is under way which will give roughly three lines of highways north and south and three east and west, with a total of about 4,500 miles. The area of Germany is about 3.2 times that of Illinois, its population eight times. On the basis of area, therefore, the German undertaking is about equivalent to the construction in Illinois of 1,400 miles of superhighways; on the population basis, to a construction of about 560 miles in the State. If, however, we base the comparison on the ratio of motor vehicle registrations, Illinois would be required to build around 6,650 miles to equal the undertaking of Germany. Without here considering either cost or details of design, the governmental situation in Germany that produced the previous conditions and those that are responsible for the present undertakings are as strongly contrasted as it is possible for opposites to be. Germany is composed of 18 states. These states, under the emperor, were responsible for the laying out and building each of its own highways. I quote Dr. Allmers, President of the National Association of the Motor Industry of Germany: "State and provincial governments, districts and communal authorities, made every effort to obstruct a sound development based on uniform principles. The Ministry of Transport was powerless, and years elapsed before applications were sanctioned by the competent governments of the federal states. Every district road engineer built his roads in a different way, but nearly all of them built them in the wrong way, and only a few appreciated the requirements of automobile traffic and these few mostly lacked the necessary funds."

Prior to the war there was no concerted national plan directed toward the building of a system of roads. It is true that the ministry of transport had a broad study under way, and while I cannot be certain, I am satisfied that the system which I saw in its developing paper stages nearly ten years ago, is the system which was the forerunner, at least, of the system which is now rapidly taking form. Undoubtedly it is changed in some respects as a national concept, and certainly the magnificent concept of the engineering and architectural designs is many times greater than was ever put forth by the old Germany. But the important point is this,—that it was not until the National Socialist Party, with its Chief, Herr Hitler, established its authoritative control over the national life, that this great scheme,—amazing both in the magnificence of its engineering and architectural design and in the speed of its realization—began to take form. One feature of it is of outstanding significance from the governmental angle.

Practically all of this system occupies wholly new right of ways. That it has been possible to obtain so quickly the locations necessary, is a demonstration that all of us who have been concerned with the securing of land necessary for public improvements must agree is a most convincing example of the power and determination of the national government of Germany.

France, through a history of at least a century and a half, has carried out major improvements through a central engineering control with all the personnel developed, or at least given final training in a single institution. In contrast, Germany almost over night upset the status of State control of planning and executing highway improvements and turned to a national plan rigidly controlled in conception and execution through the power of authoritarian government.

Acknowledgment—The foregoing is an abstract of a paper presented May 6 at the 14th Annual Meeting of the Chicago Regional Planning Association.

▼

AUTOMOBILE HIGHWAY HOTEL TO BE ERECTED IN GERMANY—Germany's first automobile highway hotel is shortly to be constructed near Olvenstedt in Saxony, adjacent to the Berlin-Magdeburg-Hanover Highway. The "hotel" provides a restaurant with sleeping accommodations for truck drivers on the ground floor and another restaurant on the second floor for the daytime use of passengers and excursionists. Four parking places will be provided, as well as two filling stations and a repair shop. The "hotel" will occupy both sides of the highway and be connected by a tunnel for pedestrians' use.

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EDITORIAL

Maintain Detours

AS ONE travels the roads of this country he strikes all kinds of detours. Detours are necessary. Some are well maintained, others are rough, muddy, bumpy, crooked and dangerous. As T. H. Dennis of the California Division of Highway says, "The ideal detour from the standpoint of traffic which will use it the most would seem to be that which most nearly parallels the existing road and at the same time provides a minimum of inconvenience in the matter of time, comfort and safety."

The best detour is none too good. Detours should be maintained to a high standard regardless of length.

There can be no economic relationship between detour maintenance costs and the number of vehicles using the detour. Costs have been kept and it has been found that they vary from one-half cent per vehicle mile to minute amounts too small to consider. Whatever the cost, it should be considered part of the cost of improving the main road, and the detour should be maintained to the best possible standard.

▼

Port of Entry

WHAT is this thing called a Port of Entry? It is a designated stopping place near the borders of some Western States where all inbound traffic, not known to the particular locality, is required to stop so that state officers of the highway law can give one the once-over. It is claimed they are established to stop gasoline bootlegging, to help locate stolen cars, and to give road information to tourists and drivers of "foreign" cars.

In Colorado the sober-faced courtesy patrol inhabit the stations. In New Mexico grim-faced officers of the highway laws hang around the dumpy looking shacks. What may be in other states is yet to be found out by the writer. One has a feeling that he's being admitted into a foreign country.

The what of the thing is not as important as the why. All these states are part of the United States. Automobile traffic glides over state lines, generally without sensing more than another bump where pavement types or road surface types change. Not so in the West. If these Ports of Entry were established as part of the national traffic survey plan, one could condone their interference. They are not, however. They are the enforcement activity to increase state highway revenues. Why private cars should be stopped is, to the writer, a mystery. No information is given unless questions are asked. Trucks are the only revenue producing factors involved, at present. Hence it seems that only trucks should be stopped.

The main purpose, of course, is to increase state revenues by enforcement of state revenue producing laws. It is granted that these mountain states need much greater funds than their population can provide to build roads. A large percentage of the cars on the roads of these mountain states are "foreign." This would seem to indicate that greater federal aid should be extended to these states. Their roads are not all well surfaced, graded and drained. They cannot afford to spend what is necessary to build high class highways. They are a part of the United States and their roads are a part of through routes of the nation.

There is no good reason why these scenic states should not be given greater federal aid. The East and Middle West should help build these costly mountain roads and Ports of Entry should be eliminated.

How unlike Michigan and Texas, for example, these border line stations are.

▼

Conveying a Concept

DIFFICULTIES frequently arise in business relationships where the language used in agreements has grown up without general understanding as to the exact shade of meaning of the word as used in the industry. Lack of standard, generally understood definitions of terms used in the motion picture industry prevented a court decision on a contract, April 20, according to "Industrial Standardization," when Judge Irving Lehman of the New York State Court of Appeals admitted that he was "unschooled" in the language used in the contract and added that before an opinion could be given the court would have to "be made literate in the language."

"The parties who made the contract presumably understood the meaning of the words they used," Judge Lehman said. "We accept the meaning which the parties agree the words were intended to have We are without guide in arriving at a construction of words where there is disagreement between the parties as to the meaning which they are intended to convey.

"The courts endeavor to apply the definitions accepted by both parties, though such definitions may be unknown to lexicographers. The parties may, if they choose, use their own special dictionaries, but when they ask the uninitiated to construe their contracts they must furnish them with dictionaries they have used. They have not done so in this case."

This very condition may easily arise in the highway construction field where terms have one meaning in common parlance and an entirely different meaning in construction usage. In fact, certain terms in highway construction do not convey the same concept to two individual engineers or contractors. There is a need for a technical dictionary of words as used in civil engineering construction and highway building.

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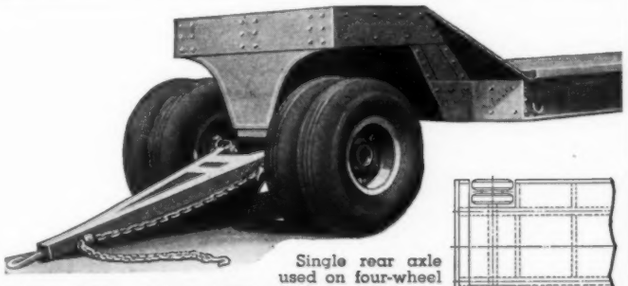
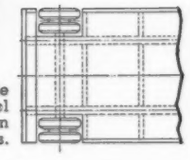
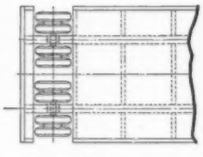


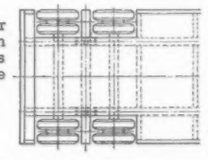
Single rear axle used on four-wheel trailers mounted on single or dual tires.



Dual axles of the oscillating type used on six-wheel trailers placed crosswise of the rear of the frame.



Tandem rear axles used on six-wheel trailers mounted on large rocker beams.



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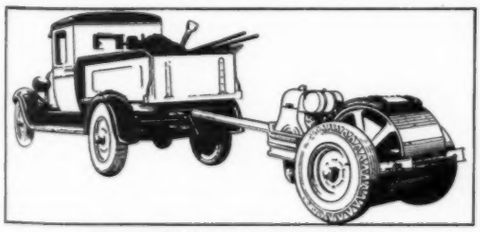

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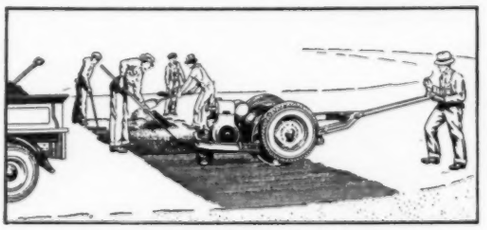

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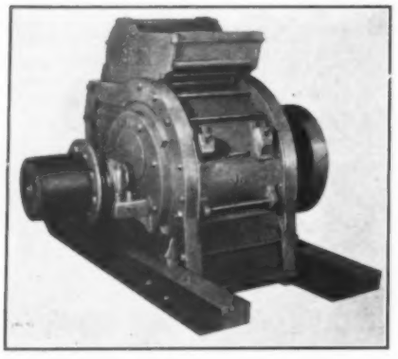


No. 70 Model "JR" Day Pulverizer

SKF double roll self aligning roller bearings are standard on all of these machines. The hammers are made of manganese steel and the grate bars are composed of high carbon tool steel bars which may be used on both sides, as well as separated for various sizes of materials.

The approximate weight of the pulverizer, or "swing-hammer," crusher on skids is 10,000 lbs. Elevators for the machine may be furnished in any desired length. Although used extensively for the production of agricultural lime, the No. 70, Model "JR" machine is used frequently for the production of road materials, chips, etc.

Several smaller new models of Day pulverizers have recently been placed on the market, all equipped with SKF roller bearings, these machines ranging in capacities of from 3 to 50 tons per hour, depending upon conditions.

▼

Improved Gardner-Denver Compressor

The Gardner-Denver Co., Quincy, Ill., has announced an improved single stage, horizontal air compressor for heavy-duty full load service and continuous operation at low power costs. Known as the "RX" Compressor, it has totally enclosed dust-proof construction without sacrifice of accessibility as well as accurate balance and freedom from vibration.

Gardner-Denver "RX" Single-Stage Horizontal Compressor.

Another important feature of the "RX" compressors is the electro-pneumatic control. With this control the compressor always starts unloaded and the air supply is automatically adjusted to fit the air requirements, resulting in exceptional part-load economy. The compressors are equipped with Timken tapered adjustable roller main bearings.

▼

New Ditcher

To meet the demand for a smaller ditcher with the operating advantages of their larger Model 160 ditcher, The Buckeye Traction Ditcher Co., Findlay, O., have brought out a new service ditcher which they are calling Model 120.

The new ditcher's most outstanding feature is its shiftable boom which enables the machine to dig right along side of curbs, close to trees, poles and other obstructions. This boom rides on two heavy steel tubes and is readily moved to either side or to any intermediate point, bringing the edge of the ditch to within 4 in. of the outside of the Alligator traction treads or within 10 in. of the overall clearance of the machine. Overall width of the machine is only 6 ft. 3 in.

Model 120 Buckeye Ditcher

Use of tubular steel boom construction is an interesting development in this new ditcher. Two telescoping sections provide means of readily adjusting the boom for normal maximum cutting depths of 6 ft., 8 ft., or 10 ft. Cutting widths range from 16 in. to 30 in.

A considerable saving in weight is affected by the use of 100 per cent electric alloy, heat treated steels throughout the machine. This adds to the ease with which the machine can be maneuvered in close quarters. Bearing pressure on the Alligator treads is reduced to approximately 9 lbs. per square inch. Low overhead clearance and low center of gravity with the boom raised for travel are advantages.

A real help on a good many jobs is the provision which is made for digging while the machine is tractioning backward. This permits tunneling under sidewalks, digging right up to building foundations, cutting manholes, etc.

Twenty selective gear speed changes forward and four in reverse give a choice of digging speeds from 2.6 in. to 89 in. per minute. Changing one sprocket doubles the speeds available.

A more complete description of the Model 120 will be found in the new bulletin which may be secured by writing to The Buckeye Traction Ditcher Co., Findlay, O.

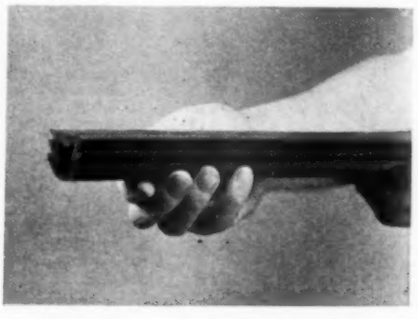
▼

Preformed Rubber Expansion Joint Filler

A new type of rubber expansion joint filler for all conventional joint openings used in concrete highways, structures, curbs, sidewalks, tanks and other miscellaneous types of construction has recently been introduced by The B. F. Goodrich Co., Akron, O.

These preformed strips are made of rubber specially compounded for great age and wear-resisting qualities. They are designed with flexible lips on the two sides, which project upward against the concrete surface of the joint opening, making their removal very difficult. In order that the strips may be easily compressed, they are made with a large tubular opening in the center. The top surface is slightly indented or grooved to provide for downward thrust of surface upon compression. Due to this latter feature, it is stated to be impossible for material to extrude above wearing surface of the pavement.

The strips are designed to be placed under partial compression as they are made about 25 per cent wider than the opening in which they are to be used. This permits the rubber to follow the concrete as it contracts and yet compress readily when the concrete expands.



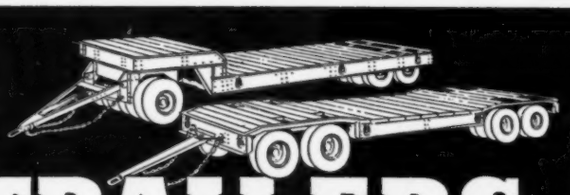
Preformed Rubber Expansion Joint Filler

The recommended method of use is to place the strips in the bottom, ends and top of the joint opening which provides a rubber gasket around the entire cross-section of the pavement or structure. These strips can also be used with the several types of joint opening devices and make very efficient seals for air cushion joints.

Advantages claimed for this new Goodrich preformed rubber expansion joint filler are that it eliminates expensive joint maintenance work; is low in cost; entails no waste through trimming; cannot be damaged by ordinary handling; is quickly installed by unskilled workmen without aid of special tools.

To date satisfactory installations of these preformed rubber strips have been made in highways in Ohio, Indiana, Michigan, the District of Columbia, Tennessee and Georgia.

LA CROSSE Heavy Duty TRAILERS



TWELVE different types . . . Five Tons to Two Hundred Tons capacity . . . Four to Sixteen Wheels . . . Two to Eight Axles . . . Designed to Avoid Highway Damage . . . Simplify your Heavy Hauling Problems . . . Write . . .

LA CROSSE TRAILER & EQUIPMENT CO., Funk Bldg., La Crosse, Wis., U. S. A.
SUBSIDIARY OF LA CROSSE BOILER COMPANY

THE LARGEST TRAILER IN THE WORLD IS A LA CROSSE !

FRONT END ATTACHMENTS

FOR INDUSTRIAL TRACTORS

Write for Circular on types, sizes and prices

ELKHART White Mfg. Co. INDIANA

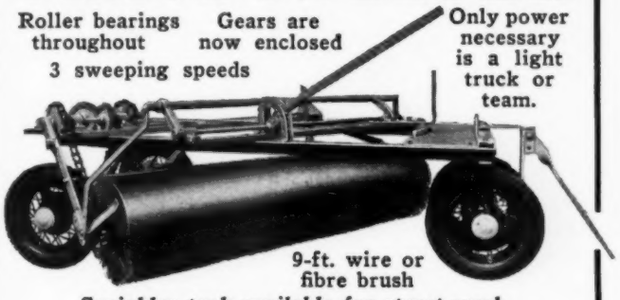
GRACE SWEEPER

Roller bearings throughout

Gears are now enclosed

3 sweeping speeds

Only power necessary is a light truck or team.



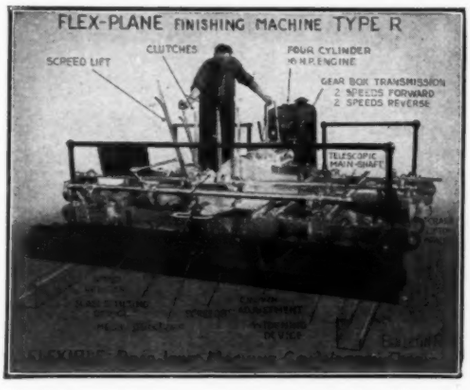
9-ft. wire or fibre brush

Sprinkler tank available for street work

W. E. GRACE CO.

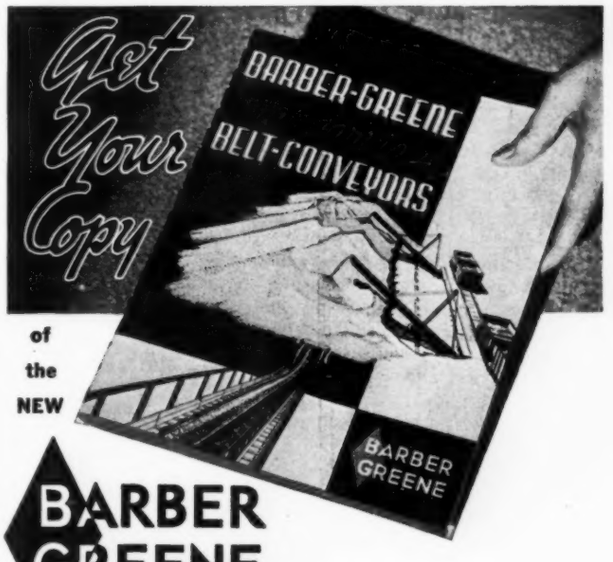
1822 Chestnut St. Dallas, Tex.

"THE FLEX-PLANE WIDE SCREED"



More speed—smoother surface—stronger concrete—back screeding—keys the aggregate in two directions—no more carrying back concrete by pitman—prevent overrun, scaling and over-agitation.

FLEXIBLE ROAD JOINT MACHINE CO.
WARREN, OHIO



BARBER GREENE

BELT CONVEYOR CATALOG AND MANUAL

MAIL TODAY— RS-7

Barber-Greene Company, Aurora, Illinois—Gentlemen: Send me without cost or obligation your new 116-page Belt Conveyor Catalog and Manual that not only shows the complete line of B-G *Standardized* Belt Conveyors, but has 20 pages devoted entirely to Engineering Data.

Name.....

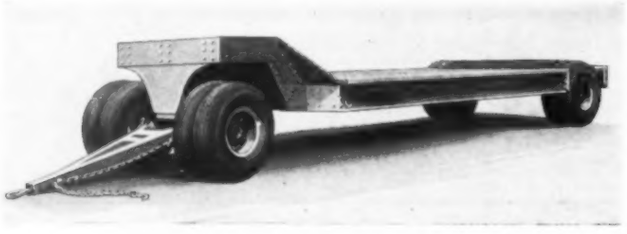
Company.....

Address.....

City..... *State*.....

New Trailer Line

A new line of trailers has been announced by C. R. Jahn Co., Builders Bldg., Chicago, Ill. Capacities from 5 to 50 tons are available either in full or semi-trailers. Three different frames are offered—drop, light kick-up, or flat platform, and practically all state regulations are conformed with by the overall widths, lengths, and wheel



New Jahn Trailer

designs of the entire line. All castings are of electric cast steel. The unusual strength and rigidity in the frame is said to be accomplished by using deeper main beam sections and a greater number of cross members, but does not increase the trailer's weight. Dual-type wheels of cast steel, heavily reinforced, roll on oversized tapered roller bearings. The small diameter of the wheels keeps the trailer bed low for easier loading and handling. The number of wheels vary from 4 to 12 according to trailer size. Those in the rear are arranged on single, tandem, or dual-tandem axles, whichever is required. In the tandem axle design the wheels are mounted on a special rocker arrangement to assure even distribution of load at all times. Oscillating front axles used on trailers of lower capacities are claimed to provide a flexibility which helps relieve frame members of strains and stresses. In the heavy-duty trailer the large diameter fifth wheel is mounted on heavy, silica manganese alloy steel springs. Brake drums are cast integral with the wheels, and the internal expanding brakes are operated by brake wheel or lever. Vacuum or air power brakes are available, however.

Standard equipment on all trailers includes loading ramps, lash rings, and Alemite or Zerk pressure grease fittings on moving parts. Safety chains are furnished on all full trailers. Side extension brackets, electric lights and reflectors, side loading ledges, push bar attachment on rear, special paint jobs and lettering, lower fifth wheel for semi-trailers, are all available as extra equipment.

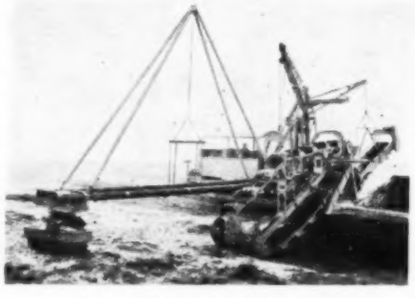
▼

New Ruth Multi-Bucket Excavator

A new excavator embodying all the advanced and proven engineering features of the Ruth dredger, with a new type bucket designed for digging under the hardest kind of conditions, has been brought out by the Ruth Dredger Manufacturing Corp., 5980 South Boyle Ave., Los Angeles, Calif. It is stated the new excavator will handle road construction much more efficiently than the Ruth dredgers.

This new Model H-V Ruth multi-bucket excavator has eight forward speeds, two in reverse and four elevator digging speeds. Forward traction speeds while working range from 1 ft. to 86 ft. per minute; reverse speeds from 2 ft. to 59 ft. per minute. The elevator digging speeds range from 20 to 47 buckets per minute, with a digging capacity of 180 cu. yd. per hour.

The forward speeds of the caterpillar crawlers are synchronized with the digging speeds of the excavating unit. The buckets have a patented positive-dump feature which ejects the entire contents of each load. The cutting teeth and cutting lips are of high abrasive resistant steel and are replaceable. The fully adjustable bucket elevator, which can be operated from either side of the main unit with equal efficiency, has a vertical movement of 7 ft. 5 in., lateral movement of 6 ft., which permits a wide range for different sizes and types of cuts and work as



New Ruth Multi-Bucket Excavator

well as maintaining an even, regular, uniform cut, regardless of the contour or irregularities of the ditch or bank. The powered extension crawler is turnable for extending or retracting, as well as for easily passing obstructions when in the spanning position. It can be telescopically spanned whatever distance is required. Special track pads to meet any working condition are available. When digging from one bank with both crawlers in close-together position, the roadway required is 7 ft. There are other models in the line to meet any size, type or condition of excavation. The adjustable power driven conveyor deposits the excavated material where desired, for loading into trucks or other carrying vehicles.

Additional information can be obtained from the manufacturers, the Ruth Dredger Manufacturing Corporation, 5980 South Boyle Ave., Los Angeles, Calif.

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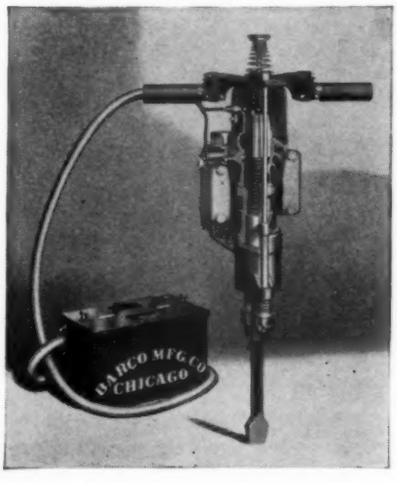
New Portable Gasoline Hammers

The Barco Manufacturing Co., Chicago, Ill., manufacturers of Barco portable gasoline hammers, have developed two new models—one known as the H-6 heavy duty type, weight 89 lbs.; the other Model J-2, weighing about 70 lbs.

The changes incorporated consist of a new timing device and rearrangement of the bottom end. The tie rod springs have been eliminated and in place of them an internal cushion spring is used. When lifting the hammer for a new location, this spring takes the shock of the blow, materially reducing the impact shock to other parts. The changes also result in giving the hammer slightly more power and reducing the vibration somewhat. A new quick acting lock for the tool is another of the features, and various other minor improvements have been incorporated.

The heavy duty, Model H-6, is recommended by the manufacturers for pavement and rock breaking, shallow drilling,



New Model Barco Portable Gasoline Hammer

backfill tamping, asphalt cutting, sheeting driving and general demolition work.

The small Model J-2 has been developed for continuous drilling and with it there is available a complete set-up, including a small portable compressor for ease in transportation to the interior and other inaccessible locations.

Detailed information will be gladly supplied upon request. Communications should be addressed to the company at 1801 Winnemac Ave., Chicago.

▼

Manager Laubach Names Gar Wood Tank Distributors

Harold C. Laubach, general manager of the tank division of Gar Wood Industries, Inc., Detroit, Mich., has announced the recent appointment of the following distributors: Ohio Equipment Co. 47-49 West Maple St., Columbus, O., and Oil Station Appliance Co., 1145 East 22nd St., Indianapolis, Ind. Mr. C. L. Combs is manager of the Ohio company which will handle the central and southern Ohio territory. Mr. Ray E. Jones heads the Indianapolis concern which will distribute Gar Wood tanks throughout the state of Indiana with the exception of the territory adjacent to Louisville, Chicago and Cincinnati.

WITH THE MANUFACTURERS

H. A. Barber Made Vice-President Barber-Greene

Mr. H. A. Barber was recently made a vice-president of Barber-Greene Co., Aurora, Ill. Mr. Barber, who received his degree in Mechanical Engineering at the University of Illinois, has acquired both practical and technical experience in all phases of the Barber-Greene line of standardized material handling machines. He has worked in virtually every department in the factory, and has done a great amount of service work in the field, particularly on B-G bituminous machines. His experience also includes research and engineering design. In his new position, Mr. H. A. Barber will continue to assist his father, Mr. H. H. Barber, President and engineering genius of the company, in the supervision of engineering and manufacturing. The officers of the Barber-Greene Co. are now Mr. H. H. Barber, President; Mr. W. B. Greene, Vice-President and Treas.; Mr. H. A. Barber, Vice-President; and Mr. D. G. McIlwraith, Secretary.

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Davey Brings Out House Organ

Publication of a new monthly house organ called *The Davey Diary* has been started by the Davey Compressor Co., Inc., Kent, O. The first issue of the new paper, which appeared July 1, was mailed to the more than 5,000 Davey salesmen, dealers, distributors, and users throughout the world. Along with it went a personal letter from Paul H. Davey, president, inviting comments and criticism. "Publication of this house organ marks the inception of a national sales and advertising program which will add materially to the profits of every Davey dealer and salesman," Mr. Davey said. Features of the first edition were illustrations and facts concerning the various Davey models, and a wealth of personal items from the Davey dealer family. The paper was edited by Arthur C. Palm, magazine writer and novelist, who is now affiliated with the Davey Company in a sales promotional capacity. Cartoon illustrations were by Howard Brown, whose drawings are featured by *Esquire, The New Yorker, Colliers,* and other national magazines.

▼

H. S. Lord Now Vice President French & Hecht

H. S. Lord who has been vice president and general manager of Hart Carter Co., Peoria, Ill., since 1929 has recently accepted a position as vice president of French & Hecht, Inc., Davenport, Ia., and will assume his new duties with the Davenport concern August 1, 1937. Mr. Lord has had a wide experience in the agricultural machinery industry, having been actively identified with it since 1908. He was connected with the Moline Plow Co., Moline, Ill., from 1912 to 1922, and consequently is no stranger to the farm equipment industry. Just prior to the time that he went with Hart Carter Co., he was vice president in charge of sales with Nichols & Shepard Co., Battle Creek, Mich., and filled the same position with the Oliver Farm Equipment Co. until he went with the Peoria concern. Mr. Lord has served for several years on the executive committee of the Farm Equipment Institute and is now a member of it.

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"Caterpillar" Promotions

Louis B. Neumiller, former manager of the central sales division for Caterpillar Tractor Co., has been named director of industrial relations for the company, a new post, created because of employment growth. Mr. Neumiller will devote his entire time to matters affecting "Caterpillar" personnel. He will leave the sales department to take office as a member of the administrative staff of the company. Years of experience with "Caterpillar" gives Mr. Neumiller an excellent background for his new duties. He first joined The Holt Manufacturing Co. in 1915, and in the engineering department there gained much valuable shop knowledge. He was promoted to superintendent of the drafting room with supervision of construction and experimental models. Transferred to the parts department in 1921, Mr. Neumiller became general parts manager. In 1930 he was placed at the head of the service department as general service manager. Last January, he became central sales division manager, which position he has held until his present advancement.

Patent No. 1981095

and that means a lot in

SPREADING MATERIAL

The Gibbes Spreader Attachment is designed for use in constructing and maintaining highways. It is particularly effective for applying crushed stone, gravel, slag and similar material on bituminous surface treatment roads.

It spreads smoothly, in uniform quantity and width and saves material and labor. It makes a better job. Proper spreading width is obtained by flaring the sides of the spreader box.

It is simple and substantial, cost is low and it will last indefinitely.

Each truck has its spreader securely bolted on and no time is lost. This means a great saving. The attachment can be removed in a few minutes.

APPROVED AND USED BY HIGHWAY DEPARTMENTS AND CONTRACTORS.

"We have not used any spreader yet that will spread stone more uniformly or that is as simple to operate. It is one of the best spreaders we have ever used."

Signed: Chas. H. Moorefield, State Highway Engineer

Also approved and used in large numbers by North Carolina Highway Department and many road builders.

Write for descriptive circulars and prices.

GIBBES MACHINERY COMPANY
COLUMBIA, S. C.

Air Compressor *from* FORD PARTS

Model A or B Ford Motor fitted with patented Smith Compressor Head with two cylinders for power and two compressing air.
Over 60 cubic feet per minute capacity. Head equipped with high speed compressor valves. Automatic unloading and idling. Widely used to operate jackhammers, paving breakers, clay spades, tampers, riveting hammers, sand blasts, paint sprays, etc.

Low first cost, light weight, economical operation, repair parts available everywhere.

Complete machines available or Smith Compressor Head and accessories with instructions for mounting.

Write for complete information and prices.

GORDON SMITH AND COMPANY, INC.
516—10th St., Bowling Green, Kentucky

for OUTPUT *that brings* BIGGER PROFIT

THE WILLIAMS MULTIPLE-ROPE BUCKET

DOUBLE HINGE gives you a longer spread of open bucket.

DOUBLE HINGE gives you a more rigid construction and greater digging strength. ***Write for new bulletin.***

Built by

THE WELLMAN ENGINEERING CO.
7020 Central Ave., CLEVELAND, OHIO

WILLIAMS
POWER-ARM, POWER-WHEEL, MULTIPLE-ROPE, DRAGLINE ..... *buckets*

Important promotions were announced by E. R. Galvin, General Sales Manager, who named Leonard J. Fletcher, former head of the agricultural sales division, as assistant general sales manager. Mr. Fletcher graduated in agricultural engineering from Iowa State College at Ames in 1915. From then until 1927, he was in charge of the agricultural engineering division at the University of California. He left that institution to join Caterpillar Tractor Co., in charge of agricultural sales. He has gained international recognition on agricultural matters. He was the first "Caterpillar" man to go to the U.S.S.R., spending the year of 1929 there, and returning for a portion of the year 1933. He directed the development of the new "Caterpillar" agricultural dealers' organization, beginning this work about two and one half years ago. His work with the company has been mostly regarding the utilization of "Caterpillar" track-type tractors in agriculture and erosion control. Mr. Fletcher is a past president of the American Society of Agricultural Engineers, and represents the ASAE in the American Engineering Council. He is a member of the Agricultural Committee of the Chamber of Commerce of the United States.

C. M. Burdette, former assistant to Mr. Neumiller, has now been advanced to manager of the central sales division. Mr. Burdette came to Caterpillar Tractor Co. six years ago from General Motors Co., where he had been associated with the Hyatt Bearing division as western manager for many years. Important among his assignments with "Caterpillar" has been the conducting of the 1936 and 1937 machinery shows, which were attended by the company's distributors and included more than 12,000 guests.

Charles A. Spears, who has been supervisor of special representatives, has been promoted to manager of allied equipment sales. Mr. Spears has been associated with Caterpillar Tractor Co. for seven years. He graduated in Civil Engineering from the University of California and as a practicing engineer gained much experience in railroading and with Los Angeles County, in California. Mr. Spears has an unusually wide acquaintance among both manufacturers and users of road machinery. He, at one time, headed the Spears-Wells Machinery Co., Oakland, Calif., which manufactured that type of equipment.

Merwin T. Farley, eastern agricultural sales supervisor, has been promoted to agricultural sales manager of the eastern division. Mr. Farley has been with the company and one of its predecessors for many years. At one time he was factory manager for the Western Harvester Co.

Floyd E. Rusher, agricultural sales manager of the eastern division, has been promoted to assistant sales manager of the central division, succeeding Mr. Burdette. Mr. Rusher has been with the company for six years, having come from the J. I. Case Co., for whom he had served as branch manager. He has also served "Caterpillar" as district representative for the central and northwest sections.

Victor A. Stibolt, French & Hecht Official, Is Dead

Victor A. Stibolt, 47, 559 26th St., Rock Island, Ill., executive vice president of French & Hecht, Inc., Davenport, Ia., died suddenly of a heart attack June 3, in his home. His death came as a distinct shock to his relatives and a wide circle of friends. He had an established reputation in the Quad-city industrial circle, and had held executive positions, with the Moline Plow Co., The Rock Island Plow Co., and Rock Island Arsenal before becoming associated with French & Hecht., Inc., in January, 1936. Mr. Stibolt was a native of Davenport, Ia., and was born Sept. 8, 1889. He received his education in Davenport public schools and Cornell University, Ithaca, N.Y. While in college he was a star track athlete, specializing in the hurdle events, and he won an intercollegiate championship for Cornell in 1911. His major in college was engineering. His first position after graduation from the engineering course was with the Robert Schaeffer Co., Chicago. A year later he went to the Moline Plow Co., as chief engineer. During the World War he served with the ordnance department of the United States army and was stationed at Rock Island arsenal. After the war he became affiliated with a lumber company at Hammond, La., returning to Rock Island in 1926 to become general manager of the Rock Island Plow Co. He returned to Hammond in 1932 and then came to Davenport. While in Louisiana he served the Southern Pine association in executive capacities. He was married May 9, 1917, in Rock Island to Miss Helen Davis, daughter of Mr. and Mrs. T. B. Davis, prominent Rock Island residents. She survives together with three sons, Victor, Thomas B., and Richard A., all at home; his mother, Mrs. Ottilie B. Stibolt, Davenport; one brother, Carl, Chicago, and one sister, Mrs. Leon Hass, Davenport.

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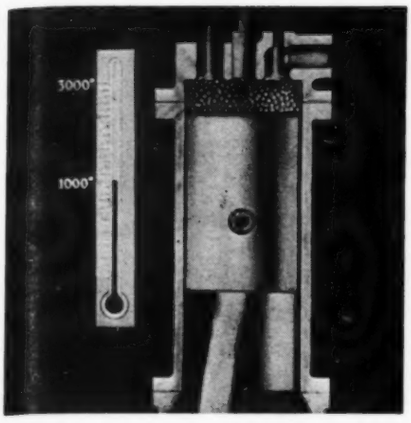
New Motion Picture Dramatizes Lubrication In Modern Industry

A unique motion picture dramatization of lubrication methods in modern industry, one of the most comprehensive studies of its kind ever attempted, was shown for the first time recently in the preview theatre of Radio City Music Hall, Rockefeller Center, New York. More than 100 representatives of the trade press saw the first public screening of the new film as guests of P. M. Gordon, Manager of the Industrial Department of the Socony-Vacuum Oil Company, producers of the picture.

The new film is done in a "March of Time" style. Unusual animated drawing and striking photography are used to illustrate correct lubrication of various types of machinery. The picture is called "The Inside Story." A microscopic film of oil assumes the hero's role in this industrial drama. But for this film of oil, the picture points out, many of the common daily conveniences of modern life, now within the reach of millions of people, would never have been possible. The



What happens inside of a Diesel engine is indicated by this scene which takes the form of an animated drawing when flashed upon the screen. The opration of the Diesel, how its works and how it is lubricated are clearly illustrated in the animation. In this photograph, the cylinder is about to compress the injected fuel and start the power stroke.

story of the fundamentals behind correct lubrication is told by showing bearings, gears and cylinders—the essential elements of all machines—and demonstrating how they operate, how they are lubricated and the lubrication needs of various types.

After a quick review of the field of industrial and mechanical progress, presented in effective photomontage, the film demonstrates the need of lubrication to protect moving parts. The spectator sees the results of friction when two highly polished surfaces move on each other. Microphotographs, enlarged until they cover the whole screen, show the reasons for friction, the fact that even highly polished surfaces are covered with hills and dales which the unaided eye cannot see. Various bearings are then shown and an animated drawing shows just what goes on inside, how lubrication prevents metal to metal contact. Factors to be taken into consideration in the selection of the proper lubricant are fully explained. In a similar way, the lubrication of gears is illustrated with animated drawings showing how a gear transmits power and how the lubricant provides protection.

Another series of pictures shows the work that correct lubrication does in protecting the moving parts of various prime motors—the Diesel engine being selected as an example. Animated drawings make clear the principle upon which the engine operates and the manner in which explosions are translated into usable power. Further drawings illustrate what a lubricant must do if efficient operation is to be maintained.

The new film will be shown to business organizations and to groups of plant managers and factory executives in industrial communities throughout the country.

▼

Hanson Co. Appoints Dealers

The Hanson Excavator Works, a division of the Hanson Clutch & Machinery Co., Tiffin, O., has appointed the following firms as Hanson dealers: The Equipment Co., 30 Prentiss St., Boston, Mass.; Dale & Rankin, Inc., 113 Frelinghuysen Ave., Newark, N. J.; Construction Equipment Co., Post Office Box 671, Hartford, Conn.; J. Shuman Hower, 85 N. Genesee St., Utica, N. Y.; R. C. Stanhope, Inc., 101 West 31st St., New York N.Y. The above firms will handle the full line of Hanson excavators from ⅜ cu. yd. to ¾ cu. yd. capacities and the full line of Hanson platform and skeleton trailers. All of these firms are well-known throughout the New England District.

▼

Bakewell Becomes Special Representative to Blaw-Knox

D. C. Bakewell

Donald C. Bakewell has resigned as vice president and chairman of the executive committee of the Continental Roll and Steel Foundry Co., in which capacity he has served since 1930, to become special representative of the Blaw-Knox Co. He will make his headquarters in the executive offices at Pittsburgh.

He is a graduate of Yale University of the Class of 1908. After two years of postgraduate work at Massachusetts Institute of Technology, he was a special apprentice for the Pennsylvania Railroad at Altoona, Pa. From 1911 to 1917, he was connected with the Duquesne Steel Foundry Co., as machinist, tool maker, assistant superintendent, assistant secretary, and secretary. In 1917, Mr. Bakewell was made president of this company and served in that capacity until the merger with Continental Roll and Steel Foundry Co., in 1930.

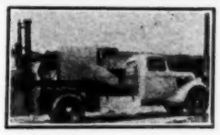
Mr. Bakewell is vice president and member of the executive committee of the Illinois Zinc Co., director of E. H. Jennings Bros. Co., director of the Coraopolis Trust Co., member of American Iron & Steel Institute, member of the advisory committe of the American Foundrymen's Association, and director and member of the executive committee of the Steel Founders Society of America.

▼

Goodrich Building Addition to Philadelphia Works

Contracts for the construction of an addition to The Philadelphia Rubber Works, reclaim division of The B. F. Goodrich Co., Akron, O., were awarded June 17 and work will be started immediately. The amount of the building contract was approximately $109,000 and Goodrich will expend in excess of $500,000 in modernizing machinery, processes and equipment in the company's reclaim division during the next six months. The construction program is the largest undertaken by Goodrich in Akron since 1929, according to Goodrich officials.

WE



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Fuller Co., Catasauqua, Pa., announces the appointment of Howard S. Sayre as manager of Chicago Office effective July 1st. Mr. Sayre has been in the employ of the Fuller Co., for a number of years, on engineering and sales work, at the home office. The Chicago Office is located at 1118 Marquette Building.

▼

NEW LITERATURE

Kentucky Rock Asphalt—A 32-page booklet, entitled "Kentucky Rock Asphalt—Specifications and Designs for Its Many Uses in Construction and Maintenance" has been issued by the Kentucky Rock Asphalt Institute, 312 South 4th St., Louisville, Ky. It is intended as a general guide and instruction book for the proper use of Kentucky sandstone rock asphalt. Definite specifications are given on which contracts may be based for the construction of a street or road surface of this material. One chapter is devoted to maintenance, repair and resurfacing.

Asphalt Pocket Reference for Highway Engineers—A new and enlarged "Asphalt Pocket Reference for Highway Engineers," Sixth Edition, written by Prevost Hubbard, Chemical Engineer and Bernard E. Gray, Chief Highway Engineer, The Asphalt Institute has been issued. Its 17 chapters, contained in 240 pages, comprise a comprehensive handbook of all phases of asphalt highway construction. Flexible, leather-finished, compacted to ⅛ in. in thickness this manual is a handy and durable vest pocket edition. Copies of this Pocket Reference Manual may be obtained without charge, from The Asphalt Institute, 801 Second Ave., New York, N.Y.

Cableway Excavators, Drag Scrapers—A useful data-book on the subject of drag scrapers, slackline excavators, tautline cable-ways, and traveling tower machines is the 84-page Sauerman Catalog No. 18 recently issued. Over 200 cuts are used to illustrate the numerous ways of applying these machines in the excavation and handling of gravel, clay, loose ores, coal, etc. and over 50 cuts showing important details of design. A copy of this catalog can be obtained by writing to Sauerman Bros., Inc., 488 S. Clinton St., Chicago.

Motorpumps—Ingersoll-Rand Co., 11 Broadway, New York, N. Y., has issued a new catalog describing its Cameron motorpumps. These pumps are compact machines combining electric motor and centrifugal pumps in a single unit. Capacities range from 5 to 1,000 gal. per min. for heads to 500 ft. Motor sizes range from ¼ to 40 HP.

New Belt Conveyor Catalog—A new 116 page belt conveyor catalog has just been published by Barber-Greene Co., Aurora, Ill., manufacturers of standardized material handling machines. This book covers the complete line of Barber-Greene standardized belt conveyors, both portable and permanent. It includes Barber-Greene stackers which have been used on many of the larger material handling jobs. 25 pages of this interesting book are devoted entirely to job photos. The belt conveyors are shown as complete units in one section and the various part and standardized unit assemblies are clearly described and illustrated in another section. This information, together with the standardization of Barber-Greene belt conveyor construction, enables the conveyor user to easily select the exact machine for his peculiar requirements. The engineering data section is complete for the engineer, and is augmented by easily understood explanations and examples for those not trained in belt conveyor practice. A copy of this new catalog will be sent to anyone writing Barber-Greene Co., Aurora, Ill.

Pumps—The new deep well turbine pump section of the Hydraulic Institute Standards has just been published. It includes definitions of deep well turbine pump parts and materials; conditions of sale; definitions of efficiencies and methods of testing; what to look for in the event of pumping troubles; charts and explanations of column friction losses and mechanical friction in turbine pump line shafts; description of power balance in a deep well turbine pump; air line method of determining depth of water level and method of plumbing a well. Price of this section is 25 ct. or it will be furnished with the complete book of standards which is priced at $1.00. Copies may be had by addressing the Secretary, C. H. ROHRBACH, 90 West St., New York, N. Y.

Low Cost Roads—A non-technical booklet on the maintenance, construction and development of unpaved road systems has just been completed by The Solvay Sales Corporation, 40 Rector St., New York, N. Y., from which a copy can be obtained. This book, which is written in easy-to-understand language, includes, among others, sections on the following: Reducing the loss of surfacing materials. Cutting blading and dragging costs. Principles of road surface stabilization. Partial or stage stabilization. Stabilized bases for pavements. Practical hints on maintenance. State, county, and township highways. City and village streets and alleys. Park and Forest Roads. Maintenance of road shoulders.

Diesel Power Units—In a new bulletin 3600-A1, Fairbanks, Morse & Co., 900 South Wabash Ave., Chicago, Ill., describes the construction and application of its Model 36 Diesel power units. The Model 36 Diesel offered in two cylinder sizes and in various combinations, with ratings as low as 10 h.p., is the smallest in the complete line of Fairbanks-Morse diesels. It is available as a completely enclosed power unit, mounted on skids and with radiator, hood and fuel tank for exposed installation; mounted on a castiron base with or without clutch and reduction gears for stationary use, and as a basic power unit for installation in portable or semi-mobile industrial and construction equipment.

Power Shovel—A new bulletin on its Badger Shovel has been issued by the Austin-Western Road Machinery Co., Aurora, Ill. Various important features of the shovel are illustrated and described, and specifications and general dimensions are given.

Flexible Metal Hose Application—The new catalog of the Chicago Metal Hose Corporation, Maywood, Ill., tells a comprehensive picture-story of the how-when-and-where to use flexible metal hose to advantage. Technical data are given on the use of flexible metal hose for various purposes. In addition to this information, the book illustrates and explains the latest developments in flexible metal hose design and construction.

Motor Grader—A bulletin announcing its "66" motor grader has been issued by the Austin-Western Road Machinery Co., Aurora, Ill. This grader has a built up power unit and is furnished with either gasoline or diesel engine. It has a 12 ft. blade.

Arc Welded Design Chart—The engineering drafting room chart brought out last fall by The Lincoln Electric Co., Cleveland, O., to provide, in concise ready reference form, data necessary for producing arc welded designs is being revised according to announcement just received from the company. The feature of the new chart will be the latest weld symbols adopted by The American Welding Society in May. The new arc welding symbols, reproduced clearly and with complete explanation on the new chart, provide means of placing complete welding information on drawings. The arc welded design chart, only one of its kind available, has been found extremely helpful in drafting rooms of companies whose products or work utilize arc welded construction. Copies of the chart can be obtained by writing The Lincoln Electric Company, Welding Engineering Department, Cleveland, Ohio.

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